THE

POPULAR SCIENCE MONTHLY.

MARCH, 1886.

BIOLOGICAL TEACHING IN COLLEGES.*

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THE general use of the word biology in this country dates from a period scarcely more remote than ten or twelve years ago, and, even at the present day, in spite of the fact that a good many of our schools and colleges announce courses on the subject, and even the newspapers occasionally discuss its popular aspects, the question is not unfrequently asked by persons generally well informed, What is biology? The question is not easily answered, for, if we say that biology is nothing but the essence of botany and zoölogy—which is the fact—then the inquirer not unreasonably asks why we now hear so much about biology, while we formerly heard only of botany and zoology, and the inference is that biology is nothing but a fine-sounding word newly coined to take the place of what used to be called natural history. This is in a certain sense true, but biology means rather natural history as it is, than natural history as it used to be, studied. It is to natural history—I use the terms as adopted in this country, without considering what their original application may have been—it is to natural history what reform is in politics: as reform seeks to elevate existing parties by forcing them to correct abuses and to infuse new life by discussing questions of the day rather than past issues, so, under the guise of biology, the attempt has been made to infuse new life into natural history by substituting for the exclusively descriptive study of plants and animals a broader science which shall include also histology, physiology, and the history of development.

* Read before the Society of Naturalists of the Eastern United States.

As a protest against a too narrow view of natural history, biology attracted a large number of advocates in this country, who hoped that the new, or, if you please, the newly named science, would not only enlarge the views of professional and amateur naturalists, but would also furnish a valuable aid in the education of the young. It is not my purpose to speak of the changed aspect of professional and expert studies, viewed from a biological stand-point, but merely to consider the effect which has been produced on elementary instruction in colleges and schools. Within the last ten years a large number of books and papers has appeared in print, intended to show teachers how to teach and students how to study plants and animals. Some of them are excellent, and certainly, as far as books go, they leave little to be desired. They all start with the advice that a beginner should study plants and animals themselves, rather than what has been written about them. In other words, the first thing is to learn to observe. In inculcating the importance of observation the modern biologists are only repeating the advice of the naturalists of the old school, although it must be said to the credit of the former that they have insisted upon observation with a frequency and urgency previously unknown. But how is one to begin? The biological method suggests a careful study of a few types which will give the beginner a general acquaintance with the essential structure of both the animal and vegetable kingdoms; whereas, by the older method, it was the fashion to study rather minutely the external characters of a considerable number of species of certain groups of plants or animals, and the general view of the two kingdoms was obtained, if obtained at all, from lectures, and not from an actual study of specimens in the laboratory.

As I have said, the new mode of study has been more or less in vogue in our leading schools and colleges for about ten years, and we ought to ask, with what success? Has it accomplished what was expected? Or, if not, what is the reason? It has been my lot to teach one branch of biology to college classes, and, as my experience seems to me to show that, in some respects, the result is disappointing, I should like to state some of the difficulties which have presented themselves in my case, not that I have lost faith in the system at all, but because my experience apparently shows that considerable improvement must still be made before the best results can be attained.

The students who come under my charge, about thirty-five annually, are probably in intelligence and industry good representatives of the average student as found in our colleges. They come from all parts of the country, and while many of them have been fitted for college at the different classical schools, where the great object is to prepare boys to answer certain examination questions, education as such being considered of very slight importance, others are fitted in schools where natural science is ostensibly taught, and others still

come from distant colleges and technical schools. The course is strictly an elementary one, and no previous knowledge of botany or zoölogy is required. As a fact, a considerable number of the class have studied botany before entering college, and, as others have not, I am able to compare the results of different methods of study in the fitting-schools.

After a few directions concerning the use of the compound microscopes placed before them, some simple material is given them to examine. Considering the large number of good books which insist upon proper training of the observing powers, and knowing how extensively they are read by teachers, I might hope that, at least, a good share of my class would know how to set to work. But what is the case? The first question asked by about three fourths of any class is sure to be, "What do you wish me to observe?" What a question! Is this the result of several years' training, that a young man eighteen years of age, or older, must be told just what to observe when a preparation is put before him? Has it come to this, that, while a boy eight or ten years old will examine with interest objects placed before him, a college student will not examine a preparation until he has been told exactly what he is to see in it? When I reply, "I wish you to examine whatever there is to be seen in your preparation," there is a look of astonishment, sometimes shading off into dismay. That an instructor should expect students to look at an object before them and make out its structure, or attempt to make out its structure, by themselves, seems to them something quite unheard of, and they evidently feel that there is a certain meanness attaching to one who will not tell them just what they must see. It has never entered their heads that, while an instructor may be able to tell them what he himself sees in the object to be studied, he can not tell them what they will see in it, and that it is only after they have studied the object for themselves and attempted to form an idea of its structure that he can explain what is obscure or correct what is erroneous. Evidently the greater part of the students regard the objects placed before them as so many diagrams, and the instructor is to serve the same purpose as the "explanation of figure so-and-so" in a text-book.

The question naturally arises, where were those who ask, "What do you wish me to observe?" fitted for college? Do they all come from the classical schools, where the only natural history studied is a three weeks' cram of Gray's "How Plants Grow"? Unfortunately, they do not. Nothing better, perhaps, could have been expected from schools where nearly all the instruction is confined to languages, and where the inquiring spirit and fondness for observation natural to children, are suppressed to a great extent. Some of the students in question have come from schools, or worse still, from colleges, where natural history is taught, and where use is made of some of the excellent books to which I have already referred. It is evident that a good book is

not enough, for there can be no doubt that many teachers take the very books which emphatically urge the necessity of observation, and use them just as they would a grammar, or a school history, so that the observation, in this case, may be said to consist in observing what is said on a certain page of a certain book, and not in watching any plant or animal.

Supposing that I am correct in believing that about three fourths of a class ask the question, "What do you wish me to observe?" there still remain one fourth who do not ask the question. Among these are some who are by nature good observers, or who have been well trained, but the number of these is very small. The remainder consists of those who have already studied biology according to the very latest method with all the modern improvements. They do not ask what I wish them to observe, but, on the contrary, begin to lecture to me about the object under consideration and things in general. If I give them some yeast to examine, they tell me at once all about its history, and show me the spores which it seems necessary that the yeast should have to make it agree with the books. It makes no difference if I substitute a quantity of starch for the yeast. If I only call it yeast, it will have all the book-marks of yeast. This over-educated class of young men is very entertaining, but very hard to teach. Everything is grist to their mill. For them the ubiquitous air-bubble makes a simple but sufficient nucleus, if it is necessary to have a nucleus, or it will serve equally well as a spore if spores are desired. Nothing is so insignificant that they can not apply to it a big name, and no theory is so complex that it can not be dragged in to explain the most self-evident cases.

I have said enough to show that, unless my experience is an exceptional one, in spite of all the talk on the subject, boys at school are not taught to observe as they should be, and that even those teachers who use good text-books frequently use them as means of imparting facts easily and quickly by the old method, rather than as an aid in the scientific training of the faculties which must form the basis of any serious study of biology. One fact has surprised me. Some of the best observers among my students have been persons who fitted at the classical schools, where the training is exclusively linguistic and mathematical. To be sure, they have been considered a bad lot by some of their instructors, and I presume that they paid little attention to their studies at school. Perhaps it is in consequence of this very neglect that their natural powers of observation have been less impaired than those of their fellows who have learned more and seen less.

It seems a great pity that students should come to college so ill-fitted, as are the majority, to undertake biological work. But we must accept things as they are, and there is no use in attempting to take the second step before the first has been taken. If the school can

not or will not teach observation, then it must be taught in college, no matter if it does seem to be child's work. In colleges, however, it is absolutely impossible to find the time or the means for training every one to become an observer, and we are obliged to distinguish between two different classes of persons in arranging courses in biology. The first and much the larger class in Eastern colleges includes all those who are preparing themselves for literary, legal, and other similar pursuits, and who wish to know the most important facts about animal and plant life, but who, after they have entered college, can not afford the time to train themselves for strictly scientific studies. This class must of necessity be taught by lectures and, perhaps, a few demonstrations, and, as far as the method is concerned, it is the same as that pursued in teaching literature, history, or other subjects in which general information is sought. Nothing further need be said with regard to biological instruction intended for this class of students, for in several of our colleges the instruction of this kind is distinctly good and constantly improving.

The second class of students includes those who are intending to become professional naturalists, teachers of natural science, or medical practitioners; in short, all who need to know plants and animals practically and the methods of biological investigation. Of course, every naturalist and teacher of natural science should have a practical acquaintance with plants and animals. So, too, should every respectable physician be trained in methods of biological study. To him every patient should be a field of research. By his own powers of observation he is to find out signs and symptoms of which the patient can not or will not give information. Merely listening to lectures, however entertaining or full of information, is not enough for this class of students. Work in the laboratory is necessary, and, in my opinion, that work had better precede any detailed course of lectures.

Being myself merely a botanist, I can only speak of the way in which plant-life may be taught, but, as far as the method of instruction is concerned, what is true of botany is, I presume, essentially true of zoölogy. Considering the age of college students, and the necessity of using the compound microscope, if one intends to make a practical study of biology, it seems to me best that the instructor should begin with some simple form like yeast or a unicellular alga.

There are other reasons besides, which make it desirable to begin with the smaller forms which can only be studied with the microscope. As it is necessary, under present conditions, to begin by teaching a student how to observe for himself, it is better to use for this purpose small forms which he has probably never seen before, or, if he has read books on biology, a mixture of several small forms which he can not recognize from pictures. The plan of recommending any text-book in the beginning is very injurious. If books are

used, by far the greater part of any class will, from mere force of habit, commit the contents, and then imagine they see everything mentioned in the books and nothing more. After they have been trained to observe, they may be allowed to consult books, but not before. What is true of books is true of lectures on objects taught in the laboratory. The students always wish to have the lecture first and see the object afterward. It seems to them to lighten the work, but they fail to recognize, what is evident to the instructor, that they are not learning so much or so well.

Again, few students have any proper conception of solid bodies, and, to train them on this point, nothing is so good as some opaque body which has to be studied by microscopic sections. For this purpose I use pieces of pine-wood which are given to the class early in the term, just as soon as they have acquired a little facility in the use of the microscope. A piece large enough to show the annual rings is given to each student, who, by looking at the rings, can tell from what part of the trunk his piece came. After some simple directions about cutting, the student is told to make sections in three directions: at right angles to the trunk, and in the directions of the radius and tangent, and in the order named. After they have made and drawn the first section, if asked what they think is the structure of the wood, almost all of them will at once say that it is composed of square cells. If one asks what they mean by square cells, they say cells shaped like dice. In classes of from thirty to forty persons, I have never found more than four or five students—in one class there was only one—who knew enough to say that they could not tell what the structure of the wood was until they had seen sections in other directions. The cross-section made, they proceed to the radial section. Having already made up their minds from the cross-section that the wood is formed of cubical cells, the radial section, with its long tubes showing the peculiar disk-like markings of coniferous wood on the walls, utterly confounds them; and it requires considerable time before they give up the attempt to make what they see in the radial section agree with the cubical cells which exist only in their own imaginations, and realize that it is only by mentally combining the transverse and radial sections that they can arrive at any correct conception of the structure of the wood. Finally, the disk-like markings are to be explained. After trying ineffectually to pass them off as nuclei, vacuoles, or other structures which they have heard are to be found in vegetable cells, they are finally induced to see whether they can not find any traces of them in the other section, and so, slowly, they make out their real nature.

No work which I ever have to do as an instructor is so utterly dreary as that of forcing students to have a correct conception of solids. It is really a lesson in solid geometry; a subject which, as we all know, many persons can only learn with great difficulty. But,

difficult or not, the training in this direction is so important that it warrants the amount of time and labor spent. As a rule, I fear, classes do not see why I give them pine-wood to study. They dislike the work very much, and feel that they have learned comparatively little. If the only object were to know the structure of pine-wood, I could tell them that in a few moments. What they have learned, without being aware of it at the time, is the way to examine solid, opaque bodies, a category including by far the greater part of biological structures. Once done with the pine-wood, progress is always comparatively rapid, and I can only conclude that the classes are strengthened by the work done on the wood.

I need not occupy your time with any further account of what can best be taught in laboratories to beginners. There is nothing to be said against the plan laid down in the manuals in common use, provided the student is not allowed to follow it mechanically, and look at nothing which is not mentioned in the book. A good instructor is, of course, so well informed about the subject he teaches that he can turn almost any material to account. In my own case, it would be very inconvenient to furnish the same material year after year; but almost anything can be used to illustrate the typical modes of growth and reproduction in the vegetable kingdom, which is what the beginner needs to know.

There are, however, a few points to be considered, which bear on the relations of the instructor to the student in college classes. It should be borne in mind that one is not dealing with school-boys, but with young men who, if they are as ignorant of biology as school-boys, have, however, learned other things, and whose development, obtained from studies at school, so far from making them better able, has, in the majority of cases, made them only the less fit to take up biological studies. If they have much to learn, they have also something to unlearn. They have been taught to rush at a fact as a bull rushes at a red rag—for the purpose of tossing it away immediately. The position of the instructor is not an easy one. He is under constant restraint, as he must not tell the student, but must, if possible, make the student tell him, the structure of what lies before him. He is in the position of a boxing-master, who might easily floor his pupil by a single blow, but who must, by the exertion of great prudence and skill, contrive to let the pupil hit him. By a judicious series of questions, suggestions of possibilities or alternatives, the student may be kept in the right track and yet do all the work of advancing toward the truth himself. Under no circumstances should an instructor let a student, who is a beginner, discover what his own views are about any point to be studied. Although they may be wretched observers of natural objects, it does not follow that students are not good judges of human nature. Without any instruction they manage to become adepts in that direction. They often hope, by the

exercise of ingenuity in detecting allusions to what they are studying, in remarks carelessly made by the instructor, to find out what his pet ideas and theories are. And where is the instructor who is not pleased to find his own favorite opinions ardently, and, as it seems, independently indorsed even by a student?

Another difficulty is the almost universal habit which students have of using technical or semi-technical terms which, in reality, convey to them no idea whatever. They think they have comprehended the *thing* when they christen it with a high-sounding *name*, and they do not stop to ask themselves whether they understand what the name means. The student who called a hole in a cell-wall a bioplast was quite pleased with his achievement until he was asked what a bioplast was. The suggestion that a hole might, without any great violence to the English language, be called a hole, was timely if not pleasing. Evidently, for an educated man, the art of calling a spade a spade is difficult to acquire. Day after day, one is obliged to ask students to translate their lingo—I don't know what else to call it—into English. Frequently they can not. At length they begin to see that they are only deceiving themselves by using words which they do not comprehend to describe structures which they do not understand. It frequently happens that, after a student has described an object under the microscope in what he considers fine scientific language, he admits that he does not understand the structure of the object at all, but, on making him start over again, and describe it in plain English, he finds that it all comes out clearly enough. It is evident, for instance, that, so long as a student thinks he must call all round bodies in cells nuclei, he will soon have such a stock of nuclei on hand that he will be hopelessly confused, and the matter is not much improved if, as a last resort, he indiscriminately calls some of his superfluous nuclei vacuoles and others bioplasts. The tendency to use meaningless words is not, by any means, confined to biological students, but, in a laboratory where one is examining something definite, the evil should certainly be checked by frequent demands for English translations of verbose rubbish.

In giving you a somewhat detailed account of my own experience, gentlemen, I am probably saying nothing new to you. It is an old story, and perhaps a monotonous one. If I have spent considerable time in stating the difficulties in the way of college instruction, it is because I see that we must first have a clear conception of what the difficulties are before we can make any real progress. The most serious obstacle, it seems to me, is not so much that boys are not taught biology at school, as that they are not taught to observe, but are, on the other hand, taught to memorize text-books, and to regard education as the acquiring of facts in the most rapid and easiest way. It is a mistake to suppose that he is the best teacher who gives the most information in the shortest time with the smallest expenditure

of labor on the part of his hearers. Such a teacher fails in a most important respect. The pupil under his guidance becomes a passive recipient of knowledge, and is not trained to rely on himself or to become an active worker in any direction. Patting one on the back and saying, "Don't you see this?" and "Don't you see that?" does not tend to produce a very robust mental development. You can not make a boy a good mountain-climber by carrying him up the Mount Washington Railway, no matter at how rapid a rate; and, in ordinary life, there are many mountains to be climbed, up which there is no railway.

As far as I can judge from the qualifications of students who come under my instruction, the schools have within the last six or seven years made no perceptible progress in training the observing powers. The good advice given and the good text-books by competent authorities have not, as yet, produced any marked effect. As far as elementary training is concerned we are about where we were ten years ago. The college-instructor must still regard the student who studies under him as a school-boy whose capacity for observing and investigating natural objects has been blunted by a one-sided course of instruction at school. Hence we are still under the necessity in college courses of beginning at the very beginning, and, if there is any mistake in our colleges, it is that the instruction in biology is pitched in too high a key. For those who are to study practically animal and plant life it is better to stick to commonplace topics for a year or two, and insist upon the careful examination of living plants and animals, before proceeding to an elaborate discussion of theories which, however great their value to mature scientific minds, would easily lead a beginner into mere vague speculation. The distinction between lecture courses for the general information of those who are not intending to enter pursuits which demand practical training in biology and courses for those who do need such training should be carefully adhered to. Again, an instructor should not hurry with his elementary classes. Knowing how much there is to be learned, he naturally feels obliged to teach as much as possible. But it is better to be slow and sure in the beginning, and, if necessary, hurry at a later stage.

One serious difficulty under which our colleges labor in laboratory instruction is the lack of a sufficient number of suitable assistants. This is not usually because properly qualified assistants can not be obtained, but because they can not be obtained for the salaries which are usually paid. In teaching elementary classes of from twenty-five to fifty persons in branches requiring the use of the compound microscope, one assistant is not enough. To do the work properly, at least two, and, better still, three assistants are needed, supposing, as is generally the case, that all the work is done on three days of the week.

The question arises whether we are ever to expect that the elements of biology will be properly taught in schools. At present there

are very few schools where they are well taught, and information is lacking to show that the number is increasing. Good books exist, but books are only of secondary importance, and certainly good teachers are few indeed. The improvement in the quality of college graduates who could teach biology in schools, if there was any demand for it, gives room for hope. Under the present fashion of cramming for college there is not much to hope for in the ordinary fitting-schools, and it would be much better if they abandoned altogether the very palpable sham which they now call botany. More could probably be accomplished in the grammar and primary schools where there is more time, and where the pupils are of an age when they naturally feel interested in plants and animals. Of course, in such schools one should begin with the larger flowering plants and not attempt to use the compound microscope. Certainly, in schools in the country or in places where the children frequently see plants growing, botany, if well taught, would be admirably adapted for awakening and developing the spirit of observation and investigation. In large cities the case is somewhat different. There the children hardly ever see plants growing, and the expense of providing them with the few flowers shown at school is hardly warranted by the good derived therefrom. As the main object is to acquire the power of observing, I am by no means certain that, in large cities, physics, or at least mechanics, may not prove to be better adapted to the purpose than botany or zoölogy.

DISCRIMINATION IN RAILWAY RATES.

By GERRIT L. LANSING.

II.

HAVING already considered those discriminations affecting persons and things, there now remains the consideration of rates affecting places.

All discriminations favoring places result from the competition existing at the favored points. This is of several kinds: First, the competition of parallel railroad lines or water-routes; second, the competition of markets; and, third, the efforts of the railroad company to increase its profits by increasing its traffic at lower rates. These operate sometimes singly, sometimes by more than one, sometimes all together. They also exist in different proportions, and so the direct effect of one or the other can not, in most cases, be measured.

I. The competition of parallel lines or water-courses includes those cases where two or more points on a railroad are accessible also by another railroad or water-route. The struggle for the traffic of such a place results in lower rates than to places less favorably situated.

If the competition is between railroads alone, the conditions of their service being approximately equal as to cost, agreements are made to abide by established tariffs, and such tariffs may be but little lower than to non-competitive points. There is, then, but little discrimination. But sooner or later the struggle for the traffic leads one road to cut the tariff rates; the other retaliates by a greater cut, and this often ends in a reckless war of rates. After the excitement of such a contest has somewhat passed away, the injuries inflicted become more felt, till at length reason leads to a restoration of the tariffs. During such a contest there is an unreasonable discrimination, as the rates are frequently less than the cost of the service. The only solution of the problem which has yet been found is to remove the incentive to cut the rates by fairly dividing the traffic between the competing lines. The common method of accomplishing this is to pool the receipts and to redistribute them on percentages based upon experience and decided by an arbitrator. This is the only instance, so far as I am informed, in which the natural principles regulating the rates of transportation lead to an unjust discrimination; and in this case the loss to the railroads, by carrying the traffic for less than cost, is perhaps greater than the injury to the community by the disturbance of values and oversupply which accompanies such contests.

So far, then, as the competition at a given place between railroads alone is concerned, the discrimination is regulated to a great extent by the harmonious working of the roads themselves. In competition with water-routes, however, on account of the inequality of their circumstances as to the cost of the service and the ease of adding new competitive boats, a discrimination must always exist. It is beyond the power of the railroad or any person or other body to prevent it, except by the heroic remedy of interdicting the traffic by rail. The water-route is free to all, its highway is furnished by nature, and the carriage is the only item of cost which must be borne by the traffic. The railroad company, on the other hand, has two existences: it is the owner of a public highway, and is a common carrier. The rate of transportation is thus composed of the toll for the use of the highway, and the charge for the service of carriage. This is a distinction which is not made in the popular mind, though it is always recognized by the law, and is important to bear in mind in the present instance; for it affords a justification of the discrimination made in favor of places having water competition, besides that contained in the necessity of the discrimination to secure the traffic.

We may take first the simple case of those places having no unusual amount of traffic, and located anywhere on the line of road, either local stations or through points; the only peculiarity about them being that they are on a competitive water-route. In those other cases where the favored places are great markets as well as competitive points, the problem becomes more complicated and will

be considered afterward. On many large railroads there are stations of no particular importance in size, which may also be reached by a river or by the sea. As they are not markets for any considerable territory, but have grown from restricted local requirements, they are not to be compared with other important depots on the same water-route. Such a place offers no more traffic to the railroad than many other local stations to which the railroad is the only means of transportation. The argument then, that the railroad should reduce its rates on account of an unusually large traffic, is foreign to the fact. The shippers simply demand that rates shall be unusually low, or the traffic will take the route by water. The terms offered to the railroad are, to take the traffic, say for illustration, at one half the rates which are charged to other places on the road of equal distances, or not to take it at all. Now, in considering the discriminations between things, we have seen that in taking traffic thus offered as compared with not taking it, the only items of expense which would be affected are connected with the cost of carriage. In either case the fixed charges must be borne by the remaining traffic. And we have also shown, in illustration, that the fixed charges in the average case may be roughly stated at two thirds of the total cost, so the traffic offered at half rates would afford a small profit above the cost of carriage. To the railroad, then, the case resolves itself into the simple question whether it will take what it can get, or go without. There is no hesitation as to the decision: the rate demanded is given from necessity.

That this is a source of no injustice to the less fortunately located places is shown from their history. Before the construction of the railroad the non-competitive points—or as many as existed at that time—were supplied with transportation solely by the slow and expensive means of animals and wagons. The construction of the railroad reduced the time and the cost of transportation to a fraction of the former amount. Along the line new towns sprang up, and both the old and the new increased in population and prosperity by the impulse to production and industries furnished by cheaper and quicker transportation. By the construction of the railroad the places which existed before increased many times in wealth and population; while to the same cause the numberless other places owe their existence. These facts are among the most prominent of the unprecedented material development of this country during the last half-century. The railroad has been to the inland places of immeasurably more benefit than to any others. It is, in fact, for these that it was constructed. The places on the water-routes were already supplied with a cheap and sufficiently rapid means of transportation; they were but incidentally passed by the railroad in the course of its extension. With the water-route the highway is furnished by nature, to the inland place it is supplied by man. The traffic must in each case alike pay the cost of carriage; but, the water-route being free to all, no toll to points on it can be

charged on any highway. As the railroad was not built for the traffic of such points, which were, before its construction, provided with transportation facilities, but was for those places to which the highways of nature did not extend, there seems no injustice in charging the expenses of the highway to the places for which it was constructed.

It is sometimes stated that non-competitive points should have rates as low as are made to competitive points; and the reason is repeated that the latter rates, which are voluntarily made by the railroad, being presumably fair, it follows that the former rates, being higher, are unfair. But, if the traffic between all points paid but the cost of carriage, there would remain no provision for the highway and the necessary fixed charges. A rigid rule, then, preventing the discrimination between these places would leave the railroad the alternative of raising the rates at the competitive points, thus losing that traffic altogether; or reducing to a little more than the cost of carriage the rates at the non-competitive points, and so losing the greater portion of its income.

II. The competition in markets is a second cause of discrimination between places. A market, to be such, must be accessible from sources of supply. Its facilities for transportation must then be in proportion to its importance. Now, the great market cities of the world were established before the application of steam to transportation by land. It is a familiar fact that the commercial cities of the world are either on rivers or the sea; so it follows that the markets come in competition with water-routes, and usually also in competition with other railroads. But the competition is more than by parallel routes carrying traffic for equal or nearly equal distances. To reach the market at all with an article produced on the line of a railroad, it must be carried at a low enough rate to enable it to be sold in competition with the same article produced perhaps much nearer the market. Grain carried five hundred miles can sell for no more than grain carried fifty miles, and, if the conditions of production are the same, the carrier must place them on an equality as to transportation. A long haul has thus to compete with a short haul, or abandon the market. If discriminations in favor of markets were not permitted, no grain could go *by rail* from Chicago and the West to the Atlantic seaboard and to Europe. But the discrimination would be made as it always has been made by the water-routes through the lakes and the St. Lawrence or Erie Canal, or down the Mississippi to New Orleans. The water-routes, however, have not an equal interest in developing the country that the railroads have; and, without the competition introduced by the latter, the rates by water would be greater than they are, and the countries whose shores they wash would be comparatively undeveloped. The railroad, in developing the resources of the country which it serves, not only secures thereby more traffic, which at the time adds to its net income; it increases as well the value of all its property. The highway being made by the railroad, and representing a large investment, a wise

policy leads to the establishment of such rates as will add to its permanent value. A temporary rate at but the cost of carriage, if necessary to establish or develop an infant industry which would in future furnish a profitable traffic, is thus justified by self-interest. To a steamer or vessel on the lakes, on the other hand, the development of the surrounding territories means but additional competition; an increase of traffic is met by an increase of boats. Their policy is to take from the traffic at the time all that can be secured, for to-morrow it will be carried by some one else.

The new supply brought to the market from a distance reduces the selling price of the article in the market, a result unfortunate to those producers nearer the market, who theretofore monopolized the trade, but fortunate for those at a greater distance who would otherwise have no market, or a more restricted one, for their products. The more important result, however, is to the general public, who are benefited through the discrimination by a reduction in the cost of the necessaries and common comforts of life; for the articles carried to the market in the greatest quantities are those which are consumed in the greatest quantities—they are the necessaries and common comforts; and, as has been already shown, it is in favor of these things particularly that discriminations are made.

III. A third cause of discrimination between places is found in the volume of the traffic. The effort of the railroad to increase its profits, by increasing its traffic through the incentive of lower rates, has already been dwelt upon in considering discriminations between things. It affects places as well. It is the principle of development, and so works upon all the traffic of a railroad and between all places. But it affects most those things or places in which there is the possibility of the greatest development. A familiar illustration of the operation of this rule is the suburban passenger traffic which has been already mentioned. The possibility of developing the travel between a great city and its suburbs is practically unlimited; accordingly every incentive is offered as to frequent and rapid trains and low rates. But between two small towns the same service and rates would be a manifest absurdity. No possible inducement, short of a payment to the passenger instead of a charge, could make any material increase in the travel, except that which slowly results from the natural increase of wealth and population. Similar causes affect the rates on freight. As things consumed in the largest quantities, in which the traffic is most capable of development, are the most favored as to rates, so also are places which consume or are markets for the greatest quantities of things. In all cases when discriminations of this nature are made in freight rates, it is where the lower rates will afford a larger net profit than the higher rates, by an increase of traffic in a greater ratio than the increase of expense. Such low rates, then, can not be at the expense of higher rates to other places. Though they may be below the

average rate of cost of the entire traffic, they are never knowingly less than the *cost of carriage* of the particular traffic.

These several causes requiring discrimination between places, viz., parallel roads or water-routes, competition of markets, and the efforts of the railroad to increase its profit by increasing its traffic at lower rates, are, in the popular mind, considered without distinction; the discrimination is as to through or local traffic. This distinction is in accord with the usual result, for through points are, in nearly all cases, the places where the most active competition of all kinds is in force. The usual termini of railroads are large cities; these again are usually on water-courses, and are usually also the chief markets reached by the road. But such is not always the case, and, when it is not, the rates will be found to be modified in accordance with the number of these forms of competition there in force, and the greater or less strength with which they exist.

This general classification of the traffic into through and local suggests a further reason why the competitive rates might fairly be expected to be lower than the local. Through points—the termini of the road—afford the longest haul, and traffic carried a long distance is, like that carried in large quantities, at a lower rate of cost per mile than that carried shorter distances. The traffic between terminal stations is usually much greater than that between any other two stations; cars are therefore loaded to their full capacity. The load at the end of the long haul is discharged, and with a delay of perhaps a day may be loaded again and returned. The local traffic is in small quantities, the car is but partly loaded, or if fully loaded the delay in unloading is as great as though it went through to the terminal station. The way-station, in the large majority of cases, affords no return load, so that the haul to some station where the car is needed, as well as the delay caused thereby, must be added to the expense. Add to these differences the difference in the volume of the traffic, and it will be readily seen that the cost per mile on through can not be but a fraction of what it is on local traffic.

Although the constant play of these competitive forces results in reducing through rates to a very low point, it deserves to be noticed that in local rates there is as well a constant though less rapid tendency to reduction. Wherever no more active forces of competition are in operation, the effort on the part of the railroad to develop the production and resources of the country by stimulating rates, and so increasing the profits and the value of the property of the company, is a cause which works constantly toward reductions. This fact is illustrated by the Railroad Commissioners of Iowa, who, in their report for 1881, occupy forty-six pages with tables and statements showing the reductions in rates in that State, and in which they particularly call attention to the fact that "the reduction is not confined to the through traffic; it applies, in a somewhat smaller ratio, it is true, to

the local traffic as well" (p. 7). And they conclude their remarks upon the subject as follows: "We venture to say that this average percentage of reduction for the last fifteen consecutive years will be a matter of no little surprise to everybody who does not make the study of freight tariffs a somewhat regular habit. Although we have made no calculation to demonstrate it, we venture to affirm that an equal average reduction in the cost of any kind of service for which the people pay a money consideration can not be found during the past fifteen years" (p. 35).

It will be seen from the foregoing that discriminations affecting places are made by nature. The distribution of land and water on the face of the earth produces a discrimination against inland places and in favor of those located on water-courses or the sea. The accessibility or inaccessibility of these places on the highway furnished by nature is the basis of the discriminations affecting them on the highway supplied by man. The rapid and cheap communication afforded by railroads has introduced a strong competitor to the water-routes, and has to a great degree reduced the inequality established by nature. But with the water-routes the highway is supplied without cost, its use is free; the *carriage* only is a charge upon the traffic. The cost of transporting by water is thus cheaper than by land, and this must always prevent the local inland rates by rail from being as low as the rates on the free water-routes.

If rates are not to be based on the principles by which, in compliance with the demands of commerce, they have heretofore been determined; if those discriminations only are to be considered fair which are based on the bulk and destructibility of articles; then the single rule remaining to apply to the discrimination of rates is that of distance —the mileage basis.

The advocates of State interference in the regulation of rates seem to be possessed with the conviction that the true basis of charge is the cost of the service, and they labor under the common error that the mileage basis is a practical method of determining this. It will be found, however, that the rates determined by the operation of commercial requirements will coincide more nearly with the cost of the service than can be the case with any artificial system which does not recognize, as elements fairly affecting rates, the value of the service, the volume of the traffic, and the competition of other routes. If the railroad is not allowed to take traffic, which can not afford to pay the standard rate, at whatever rate it can afford, if it charges more for certain traffic than the value of the transportation to the shipper, that traffic is lost. Now, the traffic that can afford to pay but very low rates is composed of things that are of low price; such, as I have already mentioned, are the necessaries of life. These things form a much greater portion of the company's traffic than any other equal number of articles. Grain, for instance, from the fields of production

in the West is carried to Chicago or St. Louis entirely by car-loads, and is forwarded thence by the train-load. Coal, petroleum, and provisions in some cases afford a regular traffic by the train-load. These articles being carried in large quantities are, as has been shown, carried at a much less rate of *cost* than things shipped in small quantities. The cost of the service thus bears an approximate relation to the rate of charge. Again, the volume of the traffic is a cause of discrimination, if by reducing the rate the traffic can be sufficiently increased to produce a greater net profit. And, again, it follows that the rate of *cost* decreases with the reduced rate of *charge*. In the reduction to meet the competition of other lines to the same market, the discrimination is also made to get the traffic which could not otherwise be secured. And the result, again, is a reduction in the rate of cost of the service by the greater traffic usual to those markets or centers of industry which are favored by the discriminating rate.

Indeed, it has sufficiently appeared that all discriminations are made to increase traffic, and those things and places are favored most which furnish the largest traffic. Now, as a larger traffic is carried at a less rate of cost, it follows that there is a constant and fundamental relation between the cost of the service and the rate of charge. There is, in fact, as close a relation as it is possible to establish between them by any system but one which would be prohibitory to a great portion of the traffic. The mileage basis of rates, however, has and continues to find many advocates, yet its impracticability has been so often illustrated that but brief mention of it seems here to be called for. Where all circumstances of value, cost, competition, and quantity are equal, a mileage rate is now applied by railroads, only reducing the rate per mile gradually as the length of haul increases, thus making the rate conform more nearly to the cost of service than if the same rate per mile were applied for all distances. This is as near as it is practicable to apply the principle, and is the rule so far as my information extends on all American roads, as it is also on European roads, operated both by private corporations and by governments. But where the circumstances of cost, competition, quantity, and value are different, that is, for the greater portion of the traffic, the principle would result in prohibition. From the preceding pages this result appears to me so apparent as to need no further comment. A statement before me, however, of an impartial and informed body (the select Committee of the Parliament of Great Britain on fares and rates of 1882), is so clear and forcible an exposition of this point, and at the same time affords an illustration of much that has herein been said on the subject of discrimination in general, that I am led to make from it the following quotation: "The form which the proposal for a fixed standard of charges has usually taken is equal mileage, i. e., a charge for each class of goods and passengers in proportion to the distance for which they are carried." This point was strongly urged before the Royal

Commission, and is so effectually disposed of by their report that it seems scarcely necessary to dwell upon it further. But it reappears in the evidence of some of the witnesses before this committee, and it may therefore be desirable to state shortly why it is impracticable:

"'(*a.*) It would prevent railway companies from lowering their fares and rates, so as to compete with traffic by sea, by canal, or by a shorter or otherwise cheaper railway, and would thus deprive the public of the benefit of competition, and the company of a legitimate source of profit.

"'(*b.*) It would prevent railway companies from making perfectly fair arrangements for carrying at a lower rate than usual goods brought in larger and constant quantities, or for carrying for long distances at a lower rate than for short distances.

"'(*c.*) It would compel a company to carry for the same rate over a line which has been very expensive in construction, or which, from gradients or otherwise, is very expensive in working, at the same rate at which it carries over less expensive lines.

"'In short, to impose equal mileage on the companies would be to deprive the public of the benefit of much of the competition which now exists, or has existed, to raise the charges on the public in many cases where the companies now find it to their interest to lower them, and to perpetuate monopolies in carriage, trade, and manufacture, in favor of those rates and places which are nearest or least expensive, where the varying charges of the companies now create competition. And it will be found that the supporters of equal mileage, when pressed, really mean, not that the rates they pay themselves are too high, but that the rates that others pay are too low. Pressed by these difficulties the proposers of equal mileage have admitted that there must be numerous exceptions, e. g., where there is sea competition (i. e., at about three fifths of the railway-stations of the United Kingdom), where low rates for long distances will bring a profit, or where the article carried at low rates is a necessary, such as coal. It is scarcely necessary to observe that exceptions such as these, while inadequate to meet all the various cases, destroy the value of equal mileage as a principle, or the possibility of applying it as a general rule.'"*

Tariffs of rates have, however, been established without discrimination, but their workings have shown that they were established with as little discretion as discernment. An illustration of such a case is afforded by the experience of Germany, the history of which is given in the testimony before the committee on fares and rates of the Parliament of Great Britain above referred to. The Government, in conformity with its military spirit, which admits of only unquestioning obedience to arbitrary orders, enforced on the railways a uniform and unvarying system of charges. Having fixed the tariffs in its own

* Report to the House of Commons, July, 1882, p. ix.

country at rates which to it were satisfactory, it adopted the principle that no through rates should be given except on the basis of these local charges. Thus traffic, for instance, between Belgium, or Holland and Austria, might be brought up to the German frontier at whatever rate those states chose to fix, but, immediately upon entering on German territory, the local tariffs should apply. As a result, the through traffic was driven from the railroads to the rivers, and exports from Austria found their way to the sea on the Elbe and the Rhine. After the enforcement of the policy had "utterly destroyed" this through traffic on the German railways, the administration decided to profit by the experience to abandon their unnatural policy, and attempt to get back the traffic. Accordingly, they issued a tariff, which is instructive as showing how completely they gave up their artificial system and recognized in railway rates the natural forces controlling commerce. The heading of the tariff reads: "Exceptional tariff to and from the German seaports, for goods traffic between Hamburg, Harburg, Bremerhaven, Geestemünde, Bremen, and Regensburg, and Passau stations. To come in force on and from March 1, 1882. This tariff will apply only to goods traversing Germany and passing beyond Regensburg and Passau, and out of the district of the German customs, and in consignments of ten tons per truck and above (wool excepted). Smaller consignments will be charged at usual rates. Articles included in the exceptional tariff." It then continues to enumerate articles under seven "special tariffs." The testimony before the commission on this subject concludes as follows: "Now that shows that the strongest government in the world, I suppose, can not interfere with the course of traffic except at its peril, and, if they attempt to impose upon the commerce of the country an impossible system, they come to grief."*

I have attempted to show that the rates on railroads are regulated by natural principles of competition, and that it is from the operation of these principles that discriminations are produced. This is but saying, in other words, that discriminating rates result from competition. An examination of the cases reported by the various State Railroad Commissioners will show that this is true; for it will be found that the discriminations effect a reduction in rates, not an increase. They are concessions made to secure traffic, which at former rates would not be carried. If this were not at least believed to be the result, there would appear no incentive for the company to make the reduction. In brief, the cause of discrimination is competition, the effect is reduction.

* Report to the House of Commons, July, 1882, pp. 170, 171.

A THINKING MACHINE.

By GRANT ALLEN.

"THINGS marvelous there are many," says the Attic dramatist, "but among them all naught moves more truly marvelous than man." And, indeed, when one begins seriously to think it over, there is no machine in all the world one-half, nay one-millionth part, so extraordinary in its mode of action as the human brain. Minutely constructed, inscrutable in all its cranks and wheels, composed of numberless cells and batteries, all connected together by microscopically tiny telegraphic wires, and so designed (whether by superior intelligence or evolutionary art) that every portion of it answers sympathetically to some fact or energy of the external universe—the human brain defies the clumsy analysis of our carving-knife anatomists, and remains to this day a great unknown and almost unmapped region, the *terra incognita* of modern physiology. If you look into any one of the ordinary human machines, with its spokes and cogs, its springs and levers, you can see at once (at least, if you have a spark of native mechanical intelligence within you) how its various portions are meant to run together, and what is the result, the actual work, to be ultimately got out of it. But not the profoundest microscopist, not the acutest psychologist, not the most learned physiologist on earth could possibly say, by inspecting a given little bit of the central nervous mechanism of humanity, why the excitation of this or that fragment of gray matter should give rise to the picture of a brown umbrella or the emotion of jealousy, why it should rather be connected with the comprehension of a mathematical problem than with the consciousness of pain or the memory of a gray-haired, military-looking gentleman whom we met three years ago at an hotel at Biarritz.

Merely to state these possible alternatives of the stimulation of a portion of the brain is sufficient to bring up vividly into view the enormous and almost inconceivable complexity of that wonderful natural mechanism. Imagine for a moment a machine so delicate that it is capable of yielding us the sensation of a strawberry-ice, the æsthetic delight of a beautiful picture, the intellectual perception of the equality of the angles at the base of an isosceles triangle, the recollection of what we all said and did the day we went for that picnic to the Dolgelly waterfalls, the vague and inconsistent dissolving views of a disturbed dream, the pain of toothache, and the delight at meeting once more an old friend who has returned from India. The very mention of such a complicated machinery, let alone the difficulty of its possession of consciousness, is enough to make the notion thus nakedly stated seem wild and absurd. Yet there the machine actually is, to answer bodily for its own possibility. You can not cavil at the accomplished

fact. It may be inconceivable, but at any rate it exists. Logic may demolish it; ridicule may explode it; metaphysics may explain it away; but, in spite of them all, it continues still imperturbably to be, and to perform the thousand-and-one incredible functions which argument conclusively and triumphantly demonstrates it can never compass. Call it materialism or what else you like, experimental physiology has now calmly demonstrated the irrefragable fact that on the brain, and on each of its parts, depends the whole of what we are and what we feel, what we see and what we suffer, what we believe and what we imagine. Everything that in our inmost souls we think of as *Us*, apart from that mere external burden, our body, is summed up in the functions and activity of a single marvelous and inscrutable organism, our human brain.

But, though physiology can tell us very little as yet about how the brain does its work, it can nevertheless tell us something; and late researches have made such a difference in our way of looking at its mode of activity, and have so upset many current and very crudely materialistic errors, that it may perhaps be worth while briefly to state, in popular and comprehensible language, how the organ of thought envisages itself in actual working process to the most advanced among our modern physiological psychologists.

Let us begin first with the old-fashioned and, as we now believe, essentially mistaken view—the view which found its fullest and most grotesque outcome in the spurious science of so-called phrenology, but which still lingers on, more or less carefully disguised, among the "localizations" and "specific energies" of many respectable modern authorities.

According to this superficial view, overtly expressed or implicitly suggested in different cases, each cell and ganglion and twist of the brain had a special function and purpose of its own to subserve, and answered to a single special element of sensation or perception, intellect or emotion. In a certain little round mass of brain-matter, in the part of the head devoted to language (if we push the theory to its extreme conclusion), must have been localized the one word "dog"; in the next little mass must have been localized "horse"; in the next, "camel," in the next again, "elephant," and so on *ad infinitum*. Here, a particular cell and fiber were intrusted with the memory of the visible orange; there, another similar little nervous element had to do with the recollection of the audible note *C* flat in the middle octave of a cottage piano. Thus reduced to its naked terms, of course, the theory sounds almost too obviously gross and ridiculous; but something like it, not quite so vividly realized or pushed so far into minute detail, was held not only by the old-fashioned phrenologists, but also by many modern and far more physiological mental philosophers.

When we come to look the question in the face, however, the mere number of cells and fibers in the human brain, immense as it undoubt-

edly is, would surely never suffice for the almost infinite variety of perceptions and facts with which our memory alone (not to mention any other mental faculty) is so abundantly stored. Suppose, for example, we take merely the human beings, living or extinct, with whose names or personalities we are more or less fully acquainted, and try to give a cell or a fiber or a ganglion to each; how many cells or fibers of ganglia would be left unappropriated at the end of the enumeration for all the rest of animate or inanimate nature, and all the other facts or sensations with which we are perfectly familiar, to say nothing of emotions, volitions, pleasures, pains, and all the other minor elements of our complex being! Let us begin, by way of experiment, with Greek history alone, and try to distribute one separate nerve-element apiece to Solon and Periander, to Themistocles and Aristides, to Herodotus and Thucydides, to Zeuxis and Pheidias, to Socrates and Plato, to Æschylus and Sophocles, to Aristides and Alexander, and so on straight through down to the very days of the Byzantine Empire. Then let us begin afresh over again, and give a cell all round to the noble Romans of our happy school-days, Romulus and Remus (myth or reality matters little for our present purpose), the seven kings and the ten decemvirs, the Curtius who leaped into the gulf and the Scævola who burned his hand off in the Etruscan fire, those terrible Scipios and those grim Gracchi, our enemy Horace with his friend Mæcenas, and so down through all the Cæsars to the second Romulus again, pretty much where we originally started. Once more, apply the same thing to English history, and allot a single brain-element apiece to everybody we can remember from Cerdic of Wessex to Queen Victoria, from Cædmon the poet, through Chaucer, Shakespeare, Milton, and Pope, to Tennyson, Swinburne, and Oscar Wilde—a cell each for all the statesmen, priests, fighters, writers, thinkers, doers, and miscellaneous nobodies whom we can possibly recall from the limbo of forgetfulness, from the days when Hengist and Horsa (alas! more myths) drove their symmetrical three keels ashore at Ebbsfleet, to the events recorded for our present edification in this evening's newspaper. (And observe in passing that, out of deference to advanced Teutonic scholarship, I have simply flung away Caractacus and Boadicea, Carausias and Allectus, and all the other vague and vaguely-remembered personalities of the earlier British and Romano-British history.) Why, by the time we had got through our historic personages alone, we should have but a very scanty remnant of places for the thousands and thousands of living individuals with whom each one of us must have come in contact, and each of whom seems to occupy a separate niche or distinct pigeonhole in the endless archives of the particular memory.

And this is only a single small department of the possibly memorable, a mere specimen category out of an innumerable collection that might equally well have been adduced in evidence. Take the animal world, for example—the creatures themselves, and not their names—

and look at the diversity of cats and dogs, goats and sheep, beetles and butterflies, soles and shrimps, that even the ordinary unlearned man knows and recognizes, and mostly remembers. Narrow the question down to dogs alone, and still you get the same result. Consider the St. Bernards and the mastiffs, the pugs and the bull-dogs, the black-and-tans and the King Charlies, the sheep-dogs and the deer-hounds, the shivering little Italian greyhounds and the long dachshunds that you buy by the yard. Every one of these and countless others has got to have its cell all to itself in the classificatory department of the human brain, and I suppose another cell for its name in the portion specially devoted to language also. Add to these the plants, flowers, fruits, roots, and other well-known vegetable products whose names are familiar to almost everybody, and what a total you have got at once! A good botanist, to take a more specific case, knows (in addition to a stock of general knowledge about equivalent on the average to anybody else's) the names and natures of hundreds and thousands of distinct plants, to say nothing about innumerable small peculiarities of stem, and leaf, and flower, and seed in every species and variety among them all. No, the mere bare weight of dead fact with which everybody's memory is stored and laden defies the possibility of reckoning and pigeon-holing. Make your separate dockets ever so tiny, reduce them all to their smallest dimensions, and yet there will not be room for all of them in the human brain. The more we think on it, the more will the wonder grow that one small head can carry all that the merest infant knows.

And now observe once more in turn a still greater and more fatal difficulty. I have spoken throughout, after the manner of men, as though each separate object, or word, or idea had a clearly defined and limited individuality, and that it could be distinctly located and circumscribed by itself in a single solitary isolated cell of the nervous mechanism. But in reality the very terms I have been obliged to use in describing the matter have themselves contained the implicit condemnation of this crude, hard, and impossible materialistic conception. For no idea and no word is, as a matter of fact, so rigidly one and indivisible, like the French Republic. Take for example once more our old friend "dog," and let us confine our attention just now to the word alone, not to the ideas connoted by it. Dog is not one word: it is a whole group and set of words. There is, first of all, the audible sound, dog, as it falls upon our ears when spoken by another. That is to say, there is, *imprimis*, dog auditory. Secondly, there is the muscular effort, dog, as it frames itself upon our own lips and vocal organs when we say it aloud to another person. That is to say, there is, *secundo*, dog pronounceable. Thirdly, there is the written or printed word, dog, DOG, in capitals or minuscules, script, or Roman, or italic, as we recognize it visibly when seen with our eyes in book or letter. That is to say, there is, *tertio*, dog legible. Now, it is quite clear that

each of these three distinct dogs is made up of separate elements, and can not possibly be regarded as being located in a single cell or fiber alone. Dog auditory is made up of the audible consonantal sound D, the audible vowel-sound aŭ or ŏ (unhappily we have no universally recognized phonetic system), and the other audible consonantal sound G hard; in that precise order of sequence and no other. Dog pronounceable is made up of an effort of breath against tongue and teeth, producing the soft dental sound D, followed by an unimpeded vocalized breath, producing the audible vowel-sound aŭ or ŏ, and closed by a stoppage of the tongue against the roof of the mouth, producing the soft palatal G. Finally, dog legible, in print at least, is composed of the separate symbols D and O and G, or d and o and g, or *d* and *o* and *g*. Yet all these distinct and unlike dogs would be unhesitatingly classed by most people under the head of language, and be located by phrenologists, with their clumsy lumping glibness, in the imaginary "bump" thereto assigned, or by more modern physiologists (whose excellent scientific work I should be the last to undervalue) in the particular convolution of the left hemisphere found to be diseased in many cases of "atactic aphasia," or loss of speech.

How infinitely more complex and varied, then, is the idea of dog, for which all these heard, spoken, written, or printed dogs are but so many rough and incomplete symbols! For the idea of dog comprises the head thereof, and the tail, the four legs, the eyes, the mouth, the nose, the neck, the body, the toes, the hair, the bark, the bite, the canine teeth that inflict it, and all the other known and remembered peculiarities of perfect doghood as ideally realizable. If we are to assign peradventure a special tract in the brain to the concept dog, it must be clear at once that that tract will be itself a very large and much subdivided region. For it must include all the separate visible attributes of the dog in general; and also it must contain as sub-species in subordination to it every kind of known dog, not only those already enumerated, but also the Eskimau dog, the Pomeranian, the French poodle, the turnspit, the Australian dingo, the Cuban bloodhound, the Gordon setter, and so forth, through every other form of dog the particular possessor of that individual brain has ever seen, cognized, or heard of. Is it not clear that, on the hypothesis of such definite and distinct localization, dog-tract alone ought to monopolize a region about one sixth as big every way as our whole assignable provision of brain-surface?

Moreover, about this point we seem to be getting ourselves into a sad muddle. For we have next to remember our own private dog, Grip, let us call him, or if you prefer it, Prince or Ponto. Now, I suppose, his name, viewed as a name, will be localized in the language department of our particular brain, and will there be arranged under the general heading of proper names, division dog-names. But there must be some intimate cross-connection between the cell or cells rep-

resenting the audible and pronounceable name Grip, or the letters G, R, I, P, and the cell or cells which have to do with the idea dog, and also, I imagine, with the name dog: for both the word Grip is intimately connected in my mind with the words "my dog," and the idea Grip is intimately connected in that same humble empirical subjectivity with the idea of dog in general. In fact, I can't think of Grip without thinking at once of his visible appearance, his personal name, and his essential dogginess of name and nature. Grip is to me a symbol, primarily, of some dog or other, and secondarily or more particularly of my dog. But whether Grip and Ponto are arranged and pigeon-holed in cells next door to one another, as being both by name dogs; or whether one is arranged under G, as in a dictionary, and the other under P (just after Pontius, for example, and just before Pontus Euxinus, both of which form distinct component elements of my verbal memory), I can not imagine. At each step in the effort to realize this wooden sort of localization, is it not clear that we are sinking deeper and deeper into a bottomless slough of utter inconceivability?

Once more (and this shall be my last attempt to point out the absurdity of the extreme cell-theory), what are we to make of the case of a man who knows more than one language? Take for example the word *chien*. Here, in one direction, all the associations and connections of idea are exactly the same as in the word *dog*. If I happen to be speaking English I say, "It's a dog"; if I happen to be speaking French, I say, "*C'est un chien*," and in both cases with just about the same idea in my mind. The picture called up by the one word is exactly the same, in most respects, as the picture called up by the other. Yet not precisely. If I write Paris, so, the notion immediately aroused in the reader's mind is that of a white and glaring brand-new city across the Channel where we all go to waste our hard-earned money at periodical intervals. But if in the preceding line I had happened to talk of Priam and Helen, the idea called up by that self-same combination of one capital letter and four small ones would have been a wholly different one, of an idyllic shepherd, as in Tennyson's "Enone," or of a handsome scamp as in (Homer's) "Iliad." If I write "baker," everybody knows I mean the man who supplies hot rolls for breakfast; but if I write "Baker," everybody is aware that I allude to Sir Samuel or to his brother the Pasha. Now, this alternative possibility is even worse in the case of *chien*. For, if I am talking French, the sight of a particular animal which usually calls up to my lips the word "dog," calls up instead the totally different word *chien*. And if the subject in hand is philology, while dog immediately suggests to me the curious practical falling out of our language of the primitive word hund, hound, now only applied to a special class of dogs, and the substitution for it of a Scandinavian and Dutch root not found in Anglo-Saxon, *chien* immediately suggests to me its ultimate

derivation from its original *canis*, and the habitual change of *c* before *a* into *ch* in the passage of words into French from Latin. By this time, I think the reader (with his usual acuteness) will begin to perceive into what a hopeless network of cross connections and crooked combinations we have managed to get ourselves in our search after the definitely localizable.

How, then, does the mechanism of the brain really act? I believe the true answer to this question is the one most fully given by M. Ribot and never yet completely accepted by English psychologists. It acts, for the most part, as a whole; or at least, even the simplest idea or mental act of any sort is a complex of processes involving the most enormously varied brain-elements. Instead of dog being located somewhere in one particular cell of the brain, dog is an idea, audible, visible, legible, pronounceable, requiring for different modes of its perception or production the co-operation of an enormous number of separate cells, fibers, and ganglia.

Let us take an illustration from a kindred case. How clumsy and awkward a supposition it would be if we were to imagine there was a muscle of dancing, and a muscle of walking, and a muscle of rowing, and a muscle of cricketing, and a muscle for the special practice of the noble art of lawn-tennis! Dancing is not a single act; it is a complex series of co-ordinated movements, implying for its proper performance the action of almost all the muscles of the body in different proportions, and in relatively fixed amounts and manners. Even a waltz is complicated enough; but when we come to a quadrille or a set of lancers, everybody can see at once that the figure consists of so many steps forward and so many back; of a bow here, and a twirl there; of hands now extended both together, and now held out one at a time in rapid succession; and so forth, throughout all the long and complicated series. A quadrille, in short, is not a name for one act, for a single movement of a single muscle, but for many acts of the whole organism, all arranged in a fixed sequence.

It is just the same with the simplest act of mental perception. Orange, for example, is not the name of a single impression; it is the name of a vast complex of impressions, all or most of which are present to consciousness in the actuality whenever we see an orange, and a great many of which are present in the idea whenever we remember or think of an orange. It is the name of a rather soft, yellow fruit, round in shape, with a thick rind, white inside, and possessing a characteristic taste and odor; a fruit divisible into several angular, juicy segments, with cells inside, and with pips of a recognized size and shape—and so forth, *ad infinitum*. In the act of perceiving an orange we exercise a number of separate nerves of sight, smell, taste, and feeling, and their connected organs in the brain as well. In the act of thinking about or remembering an orange we exercise more faintly a considerable number of these nerves and central organs, though

not, of course, all distinctly, or all together; otherwise, our mental picture of an orange would be as vivid and all-embracing as the sight of the actual orange itself.

Now, the name orange calls up more or less definitely the picture of several among these separate qualities. But it doesn't call them all up; indeed, the word in itself may not perhaps call up any of them. For instance, in the phrase, the Prince of Orange, where identical symbols meet the eye, I don't think of the fruit at all; I think, according to circumstances and context, either of William III of blessed memory, or of the eldest son of the present King of the Netherlands, whose memory (in Paris especially) is somewhat more doubtful. An orangeman and an orange-woman are not, as one might innocently imagine, correlative terms. Even without this accidental ambiguity, derived from the name of the town of Orange on the Rhône, the word orange need not necessarily connote anything more than the color by itself; as when we say that Miss Terry's dress was a deep yellow or almost orange. Nay, when we actually mean the fruit in person, not the tree, flower, or color, the picture called up will be different according to the nature of the phrase in which the word occurs. For, if I am talking about ordering dessert, the picture in my mind is that of five yellow fruits, piled up pyramid-wise on a tall center-dish; whereas, if I am talking to a botanical friend, my impression is rather that of a cross-section through a succulent fruit (known technically as a *hesperidium*), and displaying a certain familiar arrangement of cells, dissepiments, placentas, and seeds. In short, the word orange, instead of being a single unity, localizable in a single ganglion, represents a vast complex, of which now these elements are uppermost in consciousness and now those, but which seems to demand for its full realization an immense co-operation of very diverse and numerous brain-organs.

Every thought, even the simplest, involves for its production the united or associated action of a vast mass of separate brain-cells and separate brain-fibers. One thought differs from another dynamically rather than statically. It differs as running differs from dancing—not because different muscles are employed, but because the same muscles are employed in a different manner.

Trains of thought are therefore like a quadrille. One set of exercises is followed by another, which it at once suggests or sets in motion.

Of course, I do not mean to deny that every cell and fiber in the brain has its own particular use and function, any more than I would deny that each particular muscle in the body is intended to pull a particular bone or to move a particular definite organ. But what I do mean is that each such separate function is really elementary or analytical: its object is to assist in forming a conception or idea, not to contain, as it were, a whole conception ready made. Chinese sym-

bols stand each for an entire word, and it takes thousands of them to make up a language; alphabetical letters stand each, not for a word, but for an elementary sound or component of a word, and twenty-six of them do (very badly, it is true) for all the needs of our mother English. Just so, each cell or fiber in the brain does not stand for a particular word or a particular idea, but for some element of sensation or memory or feeling that goes to make up the special word or idea in question. Horse is made up of five letters, or of four phonetic sounds; it is made up also of a certain form and size and color and mode of motion; and when we speak of it all these elements are more or less vaguely present to our consciousness, coalescing into a sort of indefinite picture, and calling up one another more or less symbolically.

This theory at first sight seems to make the explanation of memory far more difficult and abstruse than formerly. For on the old hypothesis (never perhaps fully pushed to its extreme in realizable thought by any sensible person) it seemed easy enough to say that every act of perception and every fact learned was the establishment of a line of communication between two or more distinct cells or ganglia in the brain, and that the communication, once fairly established, persisted pretty constantly ever afterward. I am told "Shakespeare was born at Stratford-on-Avon"; and forthwith, cell Shakespeare (or Shakspere, or Shakspear, etc.) has a line run from it to cell birth and cell Stratford-on-Avon (a pretty complex one indeed, this last), which line remains from that day forward permeable to any similar exercise of nervous energy. This method is undeniably simple, neat, and effective. But, setting aside the difficulty of realizing that any one tract of the brain can possibly hold our whole vast mental picture of Shakespeare or of Stratford-on-Avon (especially if we have ever read the one or visited the other), there is the grotesque difficulty of the innumerable lines and cross-connections of association. A central telephone station would be the merest child's-play to it. For even so simple a word and idea as gooseberry is capable of arousing an infinite number of ideas and emotions. It may lead us at once to the old garden in the home of our childhood, or to the gooseberry-fool we ate yesterday; it may suggest the notion of playing gooseberry, or the big gooseberry of the newspaper paragraph; it may lead to etymological dissertation on its derivation from gooseberry, allied to north country grosers and French *groseille*, or it may summon up visions of bad champagne, incidentally leading to "The Vicar of Wakefield," and the famous wine manufactured only by Mrs. Primrose. In fact, I have no hesitation at all in expressing my private opinion that, if the chart of the brain were at all like what most people imagine it to be, the associations of the word gooseberry alone would suffice to give good and solid employment to every fiber, cell, and convolution it anywhere possesses.

On the other hand, if we regard the brain as mainly dynamical, as

an organism capable of very varied combinations of action, we can easily see, not only how memory becomes possible, but also how such infinite variations of association are rendered conceivable. For if every thought or perception is, as it were, an organized tremor in a vast group of diverse nerve-elements, often indeed in almost all together, it is simple enough to understand how these tremors may fall into regular rhythms, may excite one another in regular successions, may get habitual, just as the steps do in dancing, or the movements of the hand in writing a familiar and well-remembered formula—for example, in signing one's name. Here, in this immense and minutely organized workshop, we have a constant succession of motions in wheels and gearing, so arranged that each motion may be communicated in a thousand directions, and what is apparently a single impetus may call up the most diverse and extraordinary results. But, in reality, the impetus is not single: for, when we are thinking of horse in one way, we have a certain fixed form of movement called up; while, if we are thinking of it in another way, the form called up, though analogous in many respects, is far indeed from being identical. When I write "nice," you think of something or other vaguely pleasant; but, when I write "Nice," the very pronunciation is altered into something very like "niece," and the picture that rises before your mind is the very definite one of the Promenade des Anglais, with its long line of white villas and stunted palm-trees, bounded by the blue horizon of the Mediterranean and the beautiful slopes of the coast toward Villefranche. It is just the same with the apples and the oranges. The elements of the picture vary incessantly; and while one combination now suggests one association, another combination another time suggests a second. The elements join together in an infinite variety of ways, and so a finite number of cells and fibers enable us to build up all the wealth of thought, just as twenty-six tiny symbols allow us to express all the wonderful conceptions of Milton and all the beautiful ideas of Shelley. There are only fifty-two cards in a pack, it is true, but no two games of whist ever yet played, in all probability, were absolutely identical.

To sum it all up: it is the brain as a whole that thinks, and feels, and desires, and imagines, just as it is the body as a whole that walks, and swims, and digs, and dances. To locate, say, the faculty of language in a particular convolution of a particular hemisphere is almost as absurd, it seems to me, as to locate, say, the faculty of writing in the last joint of the right forefinger. Convolution and forefinger may be absolutely essential or indispensable for the proper performance of speech or writing; but to say that is not to say that the function in question is there localized. The brain as a whole is the organ of mind, but there is no organ for the word Canonbury or for the proper perception of a Mrs. Pollock geranium.—*Gentleman's Magazine.*

HEALTH AND SEX IN HIGHER EDUCATION.

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IT may not generally be known that the alumnæ of the more important centers of female higher education in this country have an organized intercollegiate association for the promotion of woman's education and the study of questions regarding her training. This association has justified its existence, if justification were necessary, by the inquiries which it has made regarding the health of those women who have pursued college courses. The importance of the results thus obtained has led to their incorporation in the "Current Report of the Massachusetts Labor Bureau." For the first time the discussion is taken from the *a priori* realm of theory on the one hand, and the hap-hazard estimate of physician and college instructor on the other. The returns have the value of all good statistics: they not only enable us to come to some conclusion upon the main point discussed, but they are so full and varied that they suggest and mark the way toward the discussion of a large number of other hardly less important questions. The figures, in short, call up as many problems as they settle, thus fulfilling the first requisite of fruitful research.

Pursuing this line, we shall first state the general character of the investigation followed and conclusions reached; and, secondly, isolate a few special problems for more detailed though brief treatment. The result may be summed up in the words of the report, as follows: "The female graduates of our colleges and universities do not seem to show, as the result of their college studies and duties, any marked difference in general health from the average health likely to be reported by an equal number of women engaged in other kinds of work. It is true that there has been, and it was to be expected that there would be, a certain deterioration in health on the part of some of the graduates. On the other hand, an almost identical improvement in health for a like number was reported, showing very plainly that we must look elsewhere for the causes of the greater part of this decline in health during college-life. If we attempt to trace the cause, we find that this deterioration is largely due, not to the requirements of college-life particularly, but to predisposing causes natural to the graduates themselves, born in them, as it were, and for which college-life or study should not be made responsible."

Through some oversight the statement is made that the returns include statistics from every higher institution in the United States open to women; while, as a matter of fact, it includes a not comparatively large number. The institutions represented, however, are typical. The data are contained in the following table:

Name of College.	Sex distinction.	Date of organization.	Total number of female graduates to 1882 inclusive.	Number of returns received.	Percentage of returns received.
Boston University.....	Co-educational.	1873	47	29	61·70
Cornell University.....	Co-educational.	1868	80	36	45·00
Kansas, University of.....	Co-educational.	1866	36	20	55·56
Mass. Institute of Technology.	Co-educational.	1865	5	3	60·00
Michigan, University of.....	Co-educational.	1841	87	46	52·87
Oberlin College.....	Co-educational.	1833	104	39	37·50
Smith College.....	Females only.	1875	90	43	47·78
Syracuse University.....	Co-educational.	1871	65	17	26·15
Vassar College.....	Females only.	1865	540	344	63·70
Wellesley College.....	Females only.	1875	110	71	64·55
Wesleyan University.....	Co-educational.	1831	15	6	40·00
Wisconsin, University of.....	Co-educational.	1849	111	51	45·95
All colleges.....		....	1,290	705	54·65

For purposes of comparison, the value of the statistics is vitiated by the fact that the date of the admission of women is not given, and this, in the cases of the co-educational college, does not agree with the date of organization. Other facts, which we omit, go to show that the average date of admission, Oberlin being excluded, may be safely put at about 1870.

The questions involved in the inquiry were exceedingly comprehensive, and may conveniently be considered under three heads, of which the first takes up the *conditions of childhood*, comprehending date of birth, nationality of parents, surroundings in childhood, amount of exercise received between the ages of eight and fourteen, the age at which study began, the age at entering college, and the age at graduation. The second section relates to *individual health*, and comprehends physical condition; nervousness; the age at beginning of the menstrual period; the conditions attending the menstrual periods; the number of graduates reporting disorders; the number of disorders; the number reporting each disorder, and the causes of disorders.

From the broad data thus obtained, the third section, a series of comparison tables, is gathered. Of these one of the most important compares the present health of graduates with the age at beginning study, the age at entering college, the time entering college after the menstrual period commenced, the amount of out-of-door exercise, and hereditary conditions. Another compares the health during college-life with the age at entering, the amount of study performed, the amount of worry about private and college affairs, etc. The first set is thus seen to be occupied with giving a picture of health through life, while the second endeavors to ascertain the changes introduced by college-life, and their causes.

The general features of the tables may be stated as follows:

Colleges.	Average Age.				
	At beginning study.	At beginning of menstrual period.	At entering college.	At graduating from college.	At present time.
Boston	5·25	13·89	19·61	23·36	26·72
Cornell	5·31	13·94	19·43	23·09	26·66
Kansas	5·25	13·65	16 32	21·75	26·35
Mass. Inst. of Tech.	6·00	13·67	21·00	24·00	25·67
Michigan	5·38	13·49	19·26	23·22	29·00
Oberlin	4·95	13·58	19·69	24·10	41·74
Smith	5·64	13·48	19·19	22·69	25·02
Syracuse	5·69	13·76	19·65	23·47	28·24
Vassar	5·91	13·61	17 81	21·96	28·95
Wellesley	5·51	13·56	18·34	22·24	24·90
Wesleyan	4·50	13·60	20·00	24·00	29·00
Wisconsin	5·49	13·57	17·98	21·69	27·24
All colleges	5·64	13·62	18·35	22·39	28·58

The influence upon health may be summed up very generally as follows: The maximum per cent of good health, 78·1, is reported at the time of entering college; during college-life this falls off to 74·9 per cent, to be followed by a rise to 77·9 per cent since graduation; fair health shows a gain from 2 to 8 per cent during college-life, followed by a decrease to 5 per cent since that time; while there was an actual decrease of 2 per cent during college-life of those having poor health, the figures being respectively 19·8 and 17·3 per cent, no appreciable change being shown for the years since graduation.

From the comparison tables it is further shown that 138, or 19·6 per cent, report a deterioration in health during college-life; 418, 59·3 per cent, no change; 149, 21·1 per cent, show an improvement. This result may be compared with the returns of the inquiries instituted by the Massachusetts Board among the working-girls of Boston, as follows: Of the 705 female college graduates, 138, or 19·58 per cent, show a deterioration in health during college-life, and of the 1,032 working-girls, 166, or 16·09 per cent, show a deterioration in health, during working-time, these figures indicating a greater loss of health, of 3·49 per cent, reported by the college graduates. For the 166 working-girls, whose health deteriorated, four had quite good health at the time of the investigation, 128 were in fair health, and 34 in poor health. Of the 138 college graduates whose health deteriorated, however, 42 report a decline in health from excellent to good, or a slight change only. Making allowances for this, there is a greater loss of health of 2·47 per cent reported by the working-girls of Boston.

Of the 705 reporting, 417, or 59 per cent, mention some disorder, and the total number of disorders reported is 865. The returns regarding the causation of disease, while not technical nor detailed enough for scientific value, are suggestive.

Of the 417 reporting disorders, 276 give the cause or causes of dis-

orders, and for 141 no cause is reported. One hundred and thirty-five consider constitutional weakness to have been the cause of disorder; 81, bad sanitary conditions; 81, intellectual overwork; 73, emotional strain; and 47, physical accidents.

The average amount of exercise reported, considering the aversion of American women, especially the educated, to bodily exertion, may be considered fairly encouraging. The average distance walked per day is given at 2·5 miles, and the time spent in other exercise as 1·2 hour. Returns regarding the amount of college-study done by college-women would gain in interest if they could be put side by side with corresponding returns from their male companions: 4, or 0·57 per cent, studied but little while at college; 438, or 62·13 per cent, studied moderately; 64, or 9·08 per cent, between moderately and severely, and 199, or 28·22 per cent, severely.

Either the lazy students failed to report, or college-women have much to learn from the average male undergraduate about the science of laziness. The lonely four, who have the courage of their disposition, all come from one college, which it would be ungallant to specify. Statistics concerning worry show that the art of taking things easy is not yet mastered by our ambitious young women: 172, or 24·40 per cent, worried over their studies; 89, or 12·62 per cent, over personal affairs; 131, or 18·58 per cent, worried over both studies and affairs; while 313, or 44·40 per cent, worried over neither studies nor affairs.

These returns for the most part tell their own tale and point their own moral. They certainly bear out the conclusion drawn regarding the uninjurious effect of collegiate study. Their great defect is in their failure to show more definitely the conditions and surroundings of college-life. The physical, social, and moral environment should be carefully studied. It has long been a commonplace of vital science that intellectual pursuits for men *per se* are healthy. The question which needs solution is, What conditions prevent their being equally healthy for women, the exact part played by each factor, and how far it is removable? What parents as well as professional educators and college administrators wish to know is, what colleges have gymnasiums, and whether the exercise is compulsory; how many institutions have matrons, and how far their influence extends; how many have resident physicians. Do the young women live herded in halls, sheltered in cottages, or at home and at boarding-houses as convenience dictates? The number of hours of sleep taken should be exactly stated. The number of hours of study should be given, instead of the vague terms "moderate," etc. Instead of indefinite inquiries as to whether the student went into society much or little, exact inquiries into the various modes of spending the hours of social recreation should be made. These and many similar points, which would suggest themselves at once, may be considered trivial; but, if we accept the general conclusion of the report that the pursuit of collegiate education is not in itself harmful,

the importance of studying the entire environment, physical and social, of the young student at once appears. Here, in fact, the problem of her education centers.

Turning from the general conclusion to the consideration of certain specific problems, we educe the following data for discussion:

By all odds the most important fact regarding the higher education of woman is, that we are educating wives and mothers. Few probably will regret this, but those few must still admit the fact in a society constituted like ours. This, then, is the heart of the situation, and, in view of it, the following statistics are suggestive:

Omitting Oberlin College, for reasons already given, 26 per cent of the graduates who report are married, the other 74 per cent single. The average number of years since graduation is, however, over six, and average age over twenty-seven. Of the married, 37 per cent are without children, although the average number of years married is 6·2. The one hundred and nine having children report 205. Of these, 12 per cent have died, and, of these deaths, 25 per cent are due to causes connected with bearing. If we include all married couples, there is but 1·2 child to every five years of married life; and, even if we exclude those not having borne any, there are, among the remainder, two children to seven years of married life. We leave these figures, as the others, to speak for themselves.

That three hundred report their post-graduate occupations as teaching, and that one hundred and sixteen are following a professional life, shows a fact too easily lost sight of. Collegiate courses for woman have not solved the problem of her *education*, but, at most, of her technical training. It can hardly be thought desirable that 60 per cent of all the young women of our country, who ought to have collegiate training, should have it only as a preparation for one of the professions or for teaching. The question of women's education, in any worthy sense of the term education, has yet to be faced. The remarkable fact that the courses for female education, as well in purely female institutions as in co-educational, run parallel with and are modeled after the curriculum of male colleges, is to be accounted for only on the ground that upon the whole their training is designed for those who have to compete with men in the professional walks of life.

If we confine ourselves to the health of women, we shall find that the figures hardly justify us in assuming a purely optimistic attitude. The following figures speak for themselves: Of those who entered college one or two years after the commencement of the menstrual period, 20·5 per cent had poor health during college-life; of those who entered three to five years after, but 17·7 per cent; and more than five years, 15·4 per cent. If we compare the ages at entering college with the relative improvement or deterioration in health, we reach the same result. Of those who entered college at sixteen years or under, 28 per cent fell off in health, while 17 per cent gained. The

figures for those of twenty and over show an almost exact reversal of these percentages, being 18 per cent loss and 28·5 per cent gain. The problem of age is thus seen to be an exceedingly important one.

The fact that, of the disorders reported, 7 per cent are brain troubles, 26 per cent of reproductive organs, and 33 per cent nervousness (also 15 per cent of neuralgia), shows that the problem of health has yet to find its adequate solution. The following percentages tell the same story: During the period of development, 53 per cent were troubled during the menstrual period (with simple irregularities, uterine or reflex pain, one or all). During college-life the per cent was 66; since graduation, 64. If we isolate simple irregularities, the result is more significant still; for these show a constant decrease, while the organic troubles show as marked an increase, the figures being, respectively, for irregularities, 16 per cent, 9 per cent, 7 per cent; for uterine and reflex pain, 24 per cent, 36 per cent, 36 per cent, for the three periods of development, college, and graduate life. Such percentages show along what line effort should be directed.

Leaving this question, we turn to the phenomena of college-life, so far as regards exercise, study, and worry, in their effects upon health. The tables here cease to have reference, in their bearing, to women alone, and point a moral for all educators to heed. The importance of exercise is shown by the fact that those reporting over two hours per day return 84 per cent in good or fair health, while those below two hours can show but 75 per cent. It is hardly an exaggeration to say that, upon the whole, the tables show that worry is the most potent of all predisposing causes of disease. Those who had no worries of account report 92 per cent in fair or good health; those worrying over both personal affairs and studies state that but 68 per cent of their number were in the same condition. Worry over personal matters seems to be more harmful to health than overstudies, 75 and 80 per cent being the proportion of good health respectively. This showing goes far in substantiating the opinion of those who hold that study *per se* is never a cause of failure of health. However, of those who studied severely, 21 per cent report poor health, against 15 per cent of those studying moderately. Again, of the latter, 54 per cent report disorders as against 70 per cent of those who studied more; the figures for nervousness also are 15 and 26 per cent respectively. It is fair to suppose, however, that the largest per cent of those worrying over their studies was found among those studying severely.

In the tables, the distinction is made between those reporting from female colleges only and those of the co-educational. It is an easy matter, however, to separate them, which I have done, with the following results: Of the whole number (705), 458 are from female colleges; 247 co-educational. For graduate life, the figures for health are exactly the same for both: 83 per cent in good health, and 17 per cent in poor. During college-life 16 per cent of the co-educa-

tionalists report poor health, as against 18 per cent of those from female colleges; but this is more than accounted for by the fact that 22 per cent of the latter were in poor health *before* entering, showing a real gain during college-life of 4 per cent in average health, while the reports of co-educational colleges show a gain of but one per cent. It must be noticed, however, that the female colleges show a falling off of 4·8 per cent from good to fair health, while the co-educational show a similar loss of but 0·3 per cent. The average number of disorders reported is much the same for each class: 1·19 for graduates of female colleges; 1·24 for the other class. The figures as given show that either more care is taken of personal health in the female colleges than in the co-educational, or that more supervision is exercised; for 55 per cent of the former report abstinence from study and exercise during the menstrual period, and only 25 per cent of the latter. The figures for disorders show no corresponding gain, however, the advantage here being on the side of the co-educational institutions, as the latter report 33 per cent of disorders of brain, nerves, and reproductive organs, against 41 per cent in the female colleges. The figures for worry are about the same in each class: 33 per cent report severe study in the co-educational colleges, as against 26 per cent in the other; the advantage in exercise is, however, somewhat on the side of the co-educational college. The figures in the causation of disorders show the same percentages arising from intellectual overwork and physical accident. The female colleges, however, report proportionately over one third more breaking down from emotional strain, while the co-educational colleges balance the account with one fourth more failing in health by reason of bad sanitary conditions.

Of the life since graduation, not much can be said: 23 per cent of the graduates of the female colleges have married; 28 per cent of the co-educational, the average age of each being the same. Competition with men seems to have led a less number of graduates of co-educational colleges to enter the professions; at all events they report but 12 per cent in the professions, while the female colleges report 21 per cent. A somewhat larger number follow teaching, however, the figures here being 48 per cent and 42 per cent respectively.

It would certainly be too much to say from these figures that the personal care and advice from others given in female colleges are greater, while the social surroundings in the co-educational colleges are healthier, because perhaps more natural; but they suggest the advisability of questions directed to these points. The female colleges seem to have the advantage in purely sanitary conditions (except amount of exercise), as witnessed by the smaller percentage reporting bad sanitation as cause of disease; by the advantage of more than two to one of abstinence from study at critical periods, and in moderation of study; while the advantage of health remains on the side of the co-educational during college-life. That the balance shifts after gradu-

ation would point in the line of the generalization already suggested; as with the cessation of college-life would cease the abnormal cloistering of the young women, while bad sanitary conditions would show comparatively permanent results. That proportionately one third more in the female colleges report emotional strain as cause of disorders, other causes showing much the same average, point in the same direction. At any rate, it is worth inquiry whether it is not possible to unite the presumed advantage of the female colleges in wise advice and proper attention to health with the freer and more natural social relations of the co-educational institutions.

It is hoped that enough has been said to show the importance of the investigations already made, and to justify the supposition that further more detailed and extended inquiries would increase their value. No educator at all acquainted with the present status of affairs will carp at the results already reached, nor will he find much but cause for thankfulness upon a survey of the field; but his outlook must be directed toward the future, not the past. Nothing could well be more fatal to the cause of woman's education than to suppose that the question is already settled. The commencement has indeed been made, but only the commencement. Mere multiplication of institutions and influences of the existing type, however valuable, as affording opportunities to individual young women, will do little toward determining the larger aspects of the case. Were the number of purely women's colleges largely increased, and were all the important boys' colleges to open their doors to girls, only the necessary *basis* for the solution of the problem would be obtained.

Such inquiries as we have briefly summarized can do more than aught else to furnish necessary data for a wise and comparatively permanent solution. Discussion on partisan lines is absolutely valueless, and *a priori* discussion will effect nothing. The unbiased study by educational experts of the fruits actually borne by experience is invaluable, and the generalizations based upon such data will show the lines upon which reform must work itself out. This is not the place to formulate the exact nature of such inquiries, but they should cover at least three heads:

I. Health.—The present report offers a valuable model to follow. More attention should be given to the social and moral environment of college-life, however, even in this point; and the discussion should more definitely concern the specifically female functions.

II. Life since Graduation.—The brief notes respecting marriages and occupations in the report discussed are all we have on this head. It should be treated with a view to determining as accurately as may be the position which the college-educated woman holds and desires to hold in the body social and politic. When we recollect the difficulty in adjusting young men's collegiate education to their life after graduation, in spite of the accumulation of infinite experience, the

value of such a report in determining the lines which woman's college education should follow, in the dearth of information upon the topic, is at once seen.

III. Specific Data for Future Movements.—These should be based upon confidential revelations made by the graduates themselves, together with the testimony of college officers and physicians. It should not be limited narrowly. They should go far beyond the question of bodily health. The statement of what each had found the greatest aid and the greatest hindrance in her collegiate training would be of much value. Experience alone can decide the exact form which these inquiries should take, but their importance can hardly be overestimated in the moral and social aspects of the case.

Education must follow the example of the special sciences. *It must organize.* There is organization, and to spare, in the schools themselves; what we want is organized recognition of the problems of education; organized study for the discovery of methods of solution; organized application of these methods in the details of school-life. Co-operation in research and application is the key to the problem.

PROEM TO GENESIS:

A REPLY TO PROFESSOR HUXLEY.

By WILLIAM E. GLADSTONE.

*VOUS avez une manière si aimable d'annoncer les plus mauvaises nouvelles, qu'elles perdent par là de leurs désagrémens.** So wrote, *de haut en bas* (from above down), the Duchess of York to Beau Brummell, sixty or seventy years back;† and so write I, *de bas en haut* (from below up), to the two very eminent champions who have in the "Nineteenth Century" of December entered appearances on behalf of Dr. Réville's *Prolégomènes*, with a decisiveness of tone, at all events, which admits of no mistake: Professor Huxley and Professor Max Müller. My first duty is to acknowledge in both cases the abundant courtesy and indulgence with which I am personally treated. And my first thought is that, where even disagreement is made in a manner pleasant, it will be a duty to search and see if there be any points of agreement or approximation, which will be more pleasant still. This indulgence and courtesy deserves in the case of Professor Huxley a special warmth of acknowledgment, because, while thus more than liberal to the individual, he has for the class of Reconcilers, in which he places me, an unconcealed and un-

* You have so gentle a way of telling the worst news that it thereby loses its unpleasantness.

† "Life," by Jesse. Revised edition, i. 260.

measured scorn. These are they who impose upon man a burden of false science *in the name of religion*, who dictate as a Divine command "an implicit belief in the cosmogony of Genesis;" and who "stir unwisdom and fanaticism to their depths."* Judgments so severe should surely be supported by citation or other evidence, for which I look in vain. To some they might suggest the idea that Passion may sometimes unawares intrude even within the precincts of the temple of Science. But I admit that a great master of his art may well be provoked, when he finds his materials tumbled about by incapable hands, and may mistake for irreverence what is only want of skill.

While acknowledging the great courtesy with which Professor Huxley treats his antagonist individually, and while simply listening to his denunciations of the Reconcilers as one listens to distant thunders, with a sort of sense that after all they will do no great harm, I must presume to animadvert with considerable freedom upon his method; upon the sweeping character of his advocacy; upon his perceptible exaggeration of points in controversy; upon his mode of dealing with authorities; and upon the curious fallacy of substitution by which he enables himself to found the widest proscriptions of the claim of the Book of Genesis to contain a Divine record upon a reasoned impeachment of its scientific accuracy in, as I shall show, a single particular.

As to the first of these topics, nothing can be more equitable than Professor Huxley's intention to intervene as a "science proctor" in that part of the debate raised by M. Réville, "to which he proposes to restrict his observations" (*P. S. M.* p. 449). This is the part on which he proposes in his first page to report as a student—and every reader will inwardly add, as one of the most eminent among all students—of natural science. Now this is not the cosmogonical part of the account in Genesis. On Genesis i. 1–19, containing the cosmogony, he does not report as an expert, but refers us (p. 859) to "those who are specially conversant with the sciences involved;" adding his opinion about their opinion. Yet in his second page, without making any reference to this broad distinction, he at once forgets the just limitation of his first, and our "proctor for science" pronounces on M. Réville's estimate, not of the fourfold succession in the stratification of the earth, but of "the account of the Creation given in the Book of Genesis," that its terms are as "respectful as in his judgment they are just" (*ibid.*). Thus the proctorship for science, justly assumed for matters within his province as a student, is rather hastily extended to matters which he himself declares to be beyond it. In truth it will appear, that as there are many roads to heaven with one ending, so, provided only a man arrives at the conclusion that the great Proem of Genesis lends no support to the argument for Revela-

* "Popular Science Monthly," February, 1886, pp. 459, 460.

tion, it does not much matter how he gets there. For in this "just" account of the Creation I have shown that M. Réville supports his accusation of scientific error by three particulars (*N. C.* p. 689): that in the first he contradicts the judgment of scholars on the sense of the original; in the second he both misquotes (by inadvertence) the terms of the text, and overlooks the distinction made so palpable (if not earlier) half a century ago, by the work of Dr. Buckland,* between *bara* and *asa;* while the third proceeds on the assumption that there could be no light to produce vegetation, except light derived from a visible sun. These three charges constitute the head and front of M. Réville's indictment against the cosmogony; and the fatal flaws in them, without any notice or defense, are now all taken under the mantle of our science proctor, who returns to the charge at the close of his article (p. 459), and again dismisses with comprehensive honor as "wise and moderate" what he had ushered in as reverent and just. So much for the sweeping, undiscriminating character of an advocacy which, in a scientific writer, we might perhaps have expected to be carefully limited and defined.

I take next the exaggeration which appears to me to mark unhappily Professor Huxley's *method.* Under this head I include all needless multiplication of points of controversy, whether in the form of overstating differences, or understating agreements, with an adversary.

As I have lived for more than half a century in an atmosphere of contention, my stock of controversial fire has perhaps become abnormally low; while Professor Huxley, who has been inhabiting the Elysian regions of science, the *edita doctrinâ sapientûm templa serena,*† may be enjoying all the freshness of an unjaded appetite. Certainly one of the lessons life has taught me is, that where there is known to be a common object, the pursuit of truth, there should also be a studious desire to interpret the adversary in the best sense his words will fairly bear; to avoid whatever widens the breach; and to make the most of whatever tends to narrow it. These I hold to be part of the laws of knightly tournament.

I do not, therefore, fully understand why Professor Huxley makes it a matter of objection to me that, in rebuking a writer who had treated evolution wholesale as a novelty in the world, I cited a few old instances of moral and historical evolution only, and did not extend my front by examining Indian sages and the founders of Greek philosophy (*P. S. M.* p. 454). Nor why, when I have spoken of physical evolution as of a thing to me most acceptable, but not yet in its rigor (to my knowledge) proved (*N. C.* p. 705), we have only the rather niggardly acknowledgment that I have made "the most oblique ad-

* "Bridgewater Treatise," vol. i. pp. 19–28. Chap. i.: "Consistency of Geological Discoveries with Sacred History."

† Lucr. ii. 8. (Serene heights raised by the learning of the wise.)

missions of a possible value" (*P. S. M.* p. 454). Thus it is when agreement is threatened, but far otherwise when differences are to be blazoned. When I have spoken of the succession of orders in the most general terms only, this is declared a sharply divided succession in which the last species of one can not overlap the first species of another (p. 457). When I have pleaded on simple grounds of reasoning for the supposition of a substantial correspondence between Genesis i. and science (*N. C.* p. 696), have waived all question of a verbal inspiration, all question whether the whole of the statements can now be made good (*N. C.* p. 694), I am treated as one of those who impose "in the name of religion" as a divine requisition "an implicit belief in the accuracy of the cosmogony of Genesis," and who deserve to have their heads broken in consequence (*P. S. M.* p. 460).

I have urged nothing "in the name of religion." I have sought to adduce probable evidence that a guidance more than human lies within the great Proem of the Book of Genesis (*N. C.* p. 694), just as I might adduce probable evidence to show that Francis did or did not write Junius, that William the Third was or was not responsible for the massacre of Glencoe; I have expressly excepted detail (p. 696), and have stated (*N. C.* p. 687) that in my inquiry "the authority of Scripture can not be alleged in proof of a primitive revelation" (*N. C.* p. 687). I object to all these exaggerations of charge, as savoring of the spirit of the Inquisition, and as restraints on literary freedom.

My next observation as to the Professor's method refers to his treatment of authorities.

In one passage (*P. S. M.* p. 450) Mr. Huxley expresses his regret that I have not named my authority for the statement made concerning the fourfold succession, in order that he might have transferred his attentions from myself to a new delinquent. Now, published works are (as I may show) a fair subject for reference. But as to pointing out any person who might have favored me with his views in private correspondence, I own that I should have some scruple in handing him over to be pilloried as a Reconciler, and to be pelted with charges of unwisdom and fanaticism, which I myself, from long use, am perfectly content to bear.

I did refer to three great and famous names: those of Cuvier, Sir John Herschel, and Whewell (*N. C.* p. 697). Mr. Huxley speaks of me as having quoted them in support of my case on the fourfold succession; and at the same time notices that I admitted Cuvier not to be a recent authority, which in geology proper is, I believe, nearly equivalent to saying he is, for particulars, no authority at all. This recital is singularly inaccurate. I cited them (*N. C.* p. 697), not with reference to the fourfold succession, but generally for "the general accordance of the Mosaic cosmogony with the results of modern inquiry" (*ibid.*), and particularly in connection with the nebular hypothesis. It is the cosmogony (Gen. i. 1–19), not the fourfold succes-

sion, which was the sole object of Réville's attack, and the main object of my defense; and which is the largest portion of the whole subject. Will Mr. Huxley venture to say that Cuvier is an unavailable authority, or that Herschel and Whewell are other than great and venerable names, with reference to the cosmogony? Yet he has quietly set them aside without notice; and they with many more are inclusively bespattered with the charges, which he has launched against the pestilent tribe of Reconcilers.

My fourth and last observation on the "method" of Professor Huxley is that, after discussing a part, and that not the most considerable part, of the Proem of Genesis, he has broadly pronounced upon the whole. This is a mode of reasoning which logic rejects, and which I presume to savor more of license than of science. The fourfold succession is condemned with argument; the cosmogony is thrown into the bargain. True, Mr. Huxley refers in a single sentence to three detached points of it partially touched in my observations (p. 453). But all my argument, the chief argument of my paper, leads up to the nebular or rotatory hypothesis (*N. C.* 689–94 and 697–8). This hypothesis, with the authorities cited—of whom one is the author of "Vestiges of the Creation"—is inclusively condemned, and without a word vouchsafed to it.

I shall presently express my gratitude for the scientific part of Mr. Huxley's paper. But there are two sides to the question. The whole matter at issue is, 1, a comparison between the probable meaning of the Proem to Genesis and the results of cosmological and geological science; 2, the question whether this comparison favors or does not favor the belief that an element of divine knowledge—knowledge which was not accessible to the simple action of the human faculties—is conveyed to us in this Proem. It is not enough to be accurate in one term of a comparison, unless we are accurate in both. A master of English may speak the vilest and most blundering French. I do not think Mr. Huxley has even endeavored to understand what is the idea, what is the intention, which his opponent ascribes to the Mosaic writer; or what is the conception which his opponent forms of the weighty word Revelation. He holds the writer responsible for scientific precision: I look for nothing of the kind, but assign to him a statement general, which admits exceptions; popular, which aims mainly at producing moral impressions; summary, which can not but be open to more or less of criticism in detail. He thinks it is a lecture. I think it is a sermon. He describes living creatures by structure. The Mosaic writer describes them by *habitat*. Both I suppose are right. I suppose that description by *habitat* would be unavailing for the purposes of science. I feel sure that description by structure, such as the geologists supply, would have been unavailing for the purpose of summary teaching with religious aim. Of Revelation I will speak by-and-by.

In order to institute with profit the comparison, now in view, the very first thing necessary is to determine, so far as the subject-matter allows, what it was that the Pentateuchal or Mosaic writer designed to convey to the minds of those for whom he wrote. The case is, in more ways than one, I conceive, the direct reverse of that which the Professor has alleged. It is not bringing Science to be tried at the bar of Religion. It is bringing Religion, so far as it is represented by this part of the Holy Scriptures, to be tried at the bar of Science. The indictment against the Pentateuchal writer is, that he has written what is scientifically untrue. We have to find then in the first place what it is that he has written, according to the text, not an inerrable text, as it now stands before us.

First, I assume there is no dispute that in Genesis i. 20–27 he has represented a fourfold sequence or succession of living organisms. Aware of my own inability to define in any tolerable manner the classes of these organisms, I resorted to the general phrases—water-population, air-population, land-population. The immediate purpose of these phrases was not to correspond with the classifications of Science, but to bring together in brief and convenient form the larger and more varied modes of expression used in verses 20, 21, 24, 25 of the Chapter.

I think, however, I have been to blame for having brought into a contact with science, which was not sufficiently defined, terms that have no scientific meaning: water-population, air-population, and (twofold) land-population. I shall now discard them and shall substitute others, which have the double advantage of being used by geologists, and perhaps of expressing better than my phrases what was in the mind of the Mosaic writer. These are the words—1, fishes; 2, birds; 3, mammals;* 4, man. By all, I think, it will be felt that the first object is to know what the Pentateuchal writer means. The relation of his meaning to science is essential, but, in orderly argumentation, subsequent. The matter now before us is a matter of reasonable and probable interpretation. What is the proper key to this hermeneutic work? In my opinion it is to be found in a just estimate of the purpose with which the author wrote, and with which the Book of Genesis was, in this part of it, either composed or compiled.

If this be the true point of departure, it opens up a question of extreme interest, at which I have but faintly glanced in my paper, and which is nowhere touched in the reply to me. What proper place has such a composition as the first Chapter of Genesis in such a work as the Scriptures of the Old Testament? They are indisputably written with a religious aim; and their subject-matter is religious. We may describe this aim in various ways. For the present purpose, suffice it to say they are conversant with belief in God, with inculcation of du-

* I wish to be understood as speaking here of the higher or ordinary mammals, which alone I assume to have been probably known to the Mosaic writer.

ties founded on that belief, with history and prophecy obviously having it for their central point. But this Chapter, at the least down to verse 25, and perhaps throughout, stands on a different ground. In concise and rapid outline, it traverses a vast region of physics. It is easy to understand Saint Paul when he speaks of the world as bearing witness to God.* What he said was capable of being verified or tested by the common experimental knowledge, of all who heard him. Of it, of our Saviour's mention of the lilies—and may it not be said generally of the references in Scripture to natural knowledge?—they are at once accounted for by the positions in which they stand. But this first Chapter of Genesis professes to set out in its own way a large and comprehensive scheme of physical facts: the transition from chaos to kosmos, from the inanimate to life, from life in its lower orders to man. Being knowledge of an order anterior to the creation of Adamic man, it was beyond verification, as being beyond experience. As a physical exposition in miniature, it stands alone in the Sacred Record. And, as this singular composition is solitary in the Bible, so it seems to be hardly less solitary in the sacred books of the world. "The only important resemblance of any ancient cosmogony with the Scriptural account, is to be found in the Persian or Zoroastrian:" This Bishop Browne† proceeds to account for on the following among other grounds: that Zoroaster was probably brought into contact with the Hebrews, and even perhaps with the prophet Daniel; a supposition which supplies the groundwork of a recent and remarkable romance, not proceeding from a Christian school.‡ Again, the Proem does not carry any Egyptian marks. In the twenty-seven thousand lines of Homer, archaic as they are and ever turning to the past, there is, I think, only one * which belongs to physiology. The beautiful sketch of a cosmogony by Ovid ‖ seems in considerable degree to follow the Mosaic outline; but it was composed at a time when the treasure of the Hebrew records had been for two centuries imparted, through the Septuagint, to the Aryan nations.

Professor Huxley, if I understand him rightly (*P. S. M.* pp. 451–2), considers the Mosaic writer, not perhaps as having intended to embrace the whole truth of science in the province of geology, but, at least as liable to be convicted of scientific worthlessness if his language will not stand the test of this construction. Thus the "water-population" is to include "the innumerable hosts of marine invertebrated animals." It seems to me that these discoveries, taken as a whole, and also taken in all their parts and particulars, do not afford a proper, I mean a rational, standard for the interpretation of the Mosaic writer; that the recent discovery of the Silurian scorpion, a highly organized animal (p. 458), is of little moment either way to the ques-

* Acts xiv. 17; Romans i. 20.
† Note on Gen. i. 5.
‡ "Zoroaster." By F. M. Crawford. Macmillan, 1885.
* *Il.* vii. 99.
‖ Ovid, "Metam." i. 1-38.

tion now before us;* that it is not an account of the extinct species which we should consider the Mosaic writer as intending to convey; that while his words are capable of covering them, as the *oikoumenè* of the New Testament covers the red and yellow man, the rules of rational construction recommend and require our assigning to them a more limited meaning, which I will presently describe.

Another material point in Professor Huxley's interpretation appears to me to lie altogether beyond the natural force of the words, and to be of an arbitrary character. He includes in it the proposition that the production of the respective orders was effected (p. 457) during each of "three distinct and successive periods of time; and only during those periods of time;" or again, in one of these, "and not at any other of these;" as, in a series of games at chess, one is done before another begins; or as in a "march-past," one regiment goes before another comes. No doubt there may be a degree of literalism which will even suffice to show that, as "every winged fowl" was produced on the fourth day of the Hexaemeron, therefore the birth of new fowls continually is a contradiction to the text of Genesis. But does not the equity of common sense require us to understand simply that the order of "winged fowl," whatever that may mean, took its place in creation at a certain time, and that from that time its various component classes were in course of production? Is it not the fact that in synoptical statements of successive events, distributed in time for the sake of producing easy and clear impressions, general truth is aimed at, and periods are allowed to overlap? If, with such a view, we arrange the schools of Greek philosophy in numerical order, according to the dates of their inception, we do not mean that one expired before another was founded. If the archæologist describes to us as successive in time the ages of stone, bronze, and iron,† he certainly does not mean that no kinds of stone implement were invented after bronze began, or no kinds of bronze after iron began. When Thucydides said that the ancient limited monarchies were succeeded by tyrannies, he did not mean that all the monarchs died at once, and a set of tyrants, like Deucalion's men, rose up and took their places. Woe be, I should say, to any one who tries summarily to present in series the phases of ancient facts, if they are to be judged under the rule of Professor Huxley.

Proceeding, on what I hold to be open ground, to state my own idea of the true key to the meaning of the Mosaic record, I suggest that

* Because my argument in no way requires universal accordance, what bearing the scorpion may have on any current scientific hypothesis, it is not for me to say.

† I use this enumeration to illustrate an argument, but I must, even in so using it, enter a caveat against its particulars. I do not conceive it to be either probable or historical that, as a general rule, mankind passed from the use of stone implements to the use of bronze, a composite metal, without passing through some intermediate (longer or shorter) period of copper.

it was intended to give moral, and not scientific, instruction to those for whom it was written. That for the Adamic race, recent on the earth, and young in faculties, the traditions here incorporated, which were probably far older than the Book, had a natural and a highly moral purpose in conveying to their minds a lively sense of the wise and loving care with which the Almighty Father, who demanded much at their hands, had beforehand given them much, in the provident adaptation of the world to be their dwelling-place, and of the created orders for their use and rule. It appears to me that, given the very nature of the Scriptures, this is clearly the rational point of view. If it is so, then, it follows, that just as the tradition described earth, air, and heaven in the manner in which they superficially presented themselves to the daily experience of man—not scientifically, but

The common air, the sun, the skies—

so he spoke of fishes, of birds, of beasts, of what man was most concerned with; and, last in the series, of man himself, largely and generally, as facts of his experience; from which great moral lessons of wonder, gratitude, and obedience were to be deduced, to aid him in the great work of his life-training.

If further proof be wanting, that what the Mosaic writer had in his mind were the creatures with which Adamic man was conversant, we have it in the direct form of verse 28, which gives to man for meat the fruit of every seed-yielding tree, and every seed-yielding herb, and the dominion of every beast, fowl, and reptile living. There is here a marked absence of reference to any but the then living species.

This, then, is the key to the meaning of the Book, and of the tradition, if, as I suppose, it was before the Book, which seems to me to offer the most probable, and therefore the rational guide to its interpretation. The question we shall have to face is whether this statement so understood, this majestic and touching lesson of the childhood of Adamic man, stands in such a relation to scientific truth, as far as it is now known, as to give warrant to the inference that the guidance under which it was composed was more than that of faculties merely human, at that stage of development, and likewise of information, which belonged to the childhood of humanity.

We have, then, before us one term of the desired comparison. Let us now turn to the other.

And here my first duty is to render my grateful thanks to Professor Huxley for having corrected my either erroneous or superannuated assumption as to the state of scientific opinion on the second and third terms of the fourfold succession of life. As one probable doctor sufficed to make an opinion probable, so the dissent of this eminent man would of itself overthrow and pulverize my proposition that there was a scientific *consensus* as to a sequence like that of Genesis in the production of animal life, as between fishes, birds,

mammals, and man. I shall compare the text of Genesis with geological statements; but shall make no attempt, unless this be an attempt, to profit by a *consensus* of geologists.

I suppose it to be admitted on all hands that no perfectly comprehensive and complete correspondence can be established between the terms of the Mosaic text and modern discovery. No one, for instance, could conclude from it that which appears to be generally recognized, that a great reptile-age would be revealed by the Mesozoic rocks.

Yet I think readers, who have been swept away by the torrent of Mr. Huxley's denunciations, will feel some surprise when on drawing summarily into line the main allegations, and especially this ruling order of the Proem, they see how small a part of them is brought into question by Mr. Huxley, and to how large an extent they are favored by the tendencies, presumptions, and even conclusions of scientific inquiry.

First, as to the cosmogony, or the formation of the earth and the heavenly bodies—

1. The first operation recorded in Genesis appears to be the formation of light. It is detached, apparently, from the waste or formless elemental mass (verses 2–5), which is left relatively dark by its withdrawal.

2. Next we hear of the existence of vapor, and of its condensation into water on the surface of the earth (verses 6–10). Vegetation subsequently begins: but this belongs rather to geology than to cosmogony (verses 11, 12).

3. In a new period, the heavenly bodies are declared to be fully formed and visible, dividing the day from the night (verses 14–18).

Under the guidance particularly of Dr. Whewell, I have referred to the nebular hypothesis as confirmatory of this account.

Mr. Huxley has not either denied the hypothesis, or argued against it. But I turn to Phillips's "Manual of Geology," edited and adapted by Mr. Seeley and Mr. Etheridge (1885). It has a section in vol. i. (pp. 15–19) on "Modern Speculations concerning the Origin of the Earth."

The first agent here noticed as contributing to the work of production is the "gas hydrogen in a burning state," which now "forms the enveloping portion of the sun's atmosphere;" whence we are told the inference arises that the earth also was once "incandescent at its surface," and that its rocks may have been "products of combustion." Is not this representation of light with heat for its ally, as the first element in this Speculation, remarkably accordant with the opening of the Proem to Genesis?

Next it appears (*ibid.*) that "the product of this combustion is vapor," which with diminished heat condenses into water, and eventually accumulates "in depressions on the sun's surface so as to form oceans and seas." "It is at least probable that the earth has passed

through a phase of this kind" (*ibid.*). "The other planets are apparently more or less like the earth in possessing atmospheres and seas." Is there not here a remarkable concurrence with the second great act of the cosmogony?

Plainly, as I suppose it is agreeable to these suppositions that, as vapor gradually passes into water, and the atmosphere is cleared, the full adaptation of sun and moon by visibility for their functions should come in due sequence, as it comes in Gen. i. 14–18.

Pursuing its subject, the Manual proceeds (p. 17): "This consideration leads up to what has been called the nebular hypothesis," which "supposes that, before the stars existed, the materials of which they consist were diffused in the heavens in a state of vapor" (*ibid.*). The text then proceeds to describe how local centers of condensation might throw off rings, these rings break into planets, and the planets, under conditions of sufficient force, repeat the process, and thus produce satellites like those of Saturn, or like the moon.

I therefore think that, so far as cosmogony is concerned, the effect of Mr. Huxley's paper is not by any means to leave it as it was, but to leave it materially fortified by the Manual of Geology, which I understand to be a standard of authority at the present time.

Turning now to the region of that science, I understand the main statements of Genesis, in successive order of time, but without any measurement of its divisions, to be as follows:

1. A period of land, anterior to all life (verses 9, 10).
2. A period of vegetable life, anterior to animal life (verses 11, 12).
3. A period of animal life, in the order of fishes (verse 20).
4. Another stage of animal life, in the order of birds.
5. Another, in the order of beasts (verses 24, 25).
6. Last of all, man (verses 26, 27).

Here is a chain of six links, attached to a previous chain of three. And I think it not a little remarkable that of this entire succession, the only step directly challenged is that of numbers four and five, which (p. 457) Mr. Huxley is inclined rather to reverse. He admits distinctly the seniority of fishes. How came that seniority to be set down here? He admits as probable upon present knowledge, in the person of *Homo sapiens*, the juniority of man (p. 455). How came this juniority to be set down here? He proceeds indeed to describe an opposite opinion concerning man as holding exactly the same rank as the one to which he had given an apparent sanction (*ibid.*). As I do not precisely understand the bearing of the terms he uses, I pass them by, and I shall take the liberty of referring presently to the latest authorities, which he has himself suggested that I should consult. But I add to the questions I have just put this other inquiry. How came the Mosaic writer to place the fishes and the men in their true relative positions not only to one another, and not only to the rest of the animal succession, but in a definite and that a true relation of time to the ori-

gin of the first plant-life, and to the colossal operations by which the earth was fitted for them all? Mr. Huxley knows very well that it would be in the highest degree irrational to ascribe this correct distribution to the doctrine of chances; nor will the stone of Sisyphus of itself constitute a sufficient answer to inquiries which are founded, not upon a fanciful attempt to equate every word of the Proem with every *dictum* of science, but upon those principles of probable reasoning by which all rational lives are and must be guided.

I find the latest published authority on geology in the Second or Mr. Etheridge's volume of the Manual * of Professor Phillips, and by this I will now proceed to test the sixfold series which I have ventured upon presenting.

First, however, looking back for a moment to a work, obviously of the highest authority,† on the geology of its day, I find in it a table of the order of appearance of animal life upon the earth, which, begining with the oldest, gives us—

1. Invertebrates	4. Birds
2. Fishes	5. Mammals
3. Reptiles	6. Man.

I omit all reference to specifications, and speak only of the principal lines of division.

In the Phillips-Etheridge Manual, beginning as before with the oldest, I find the following arrangement, given partly by statement and partly by diagram:

1. "The Azoic or Archæan time of Dana;" called prè-Cambrian by other physicists (pp. 3, 5).

2. A commencement of plant-life indicated by Dana as anterior to invertebrate animal life; long anterior to the vertebrate forms, which alone are mentioned in Genesis (pp. 4, 5).

3. Three periods of invertebrate life.

4. Age of fishes.

5. Age of reptiles.

6. Age of mammals, much less remote.

7. Age of man, much less remote than mammals.

As to birds, though they have not a distinct and separate age assigned them, the Manual (vol. i. ch. xxv. pp. 511–20) supplies us very clearly with their place in "the succession of animal life." We are here furnished with the following series, after the fishes: 1. Fossil reptiles (p. 512); 2. Ornithosauria (p. 517); they were "flying animals, which combined the characters of reptiles with those of birds;" 3. The first birds of the secondary rocks with "feathers in all respects similar to those of existing birds" (p. 518); 4. Mammals (p. 520).

* Phillips's "Manual of Geology" (vol. ii.) part ii., by R. Etheridge, F.R.S. New edition, 1885.

† "Palæontology," by Richard Owen (now Sir Richard Owen, K.C.B.). Second edition, p. 5, 1861.

I have been permitted to see in proof another statement from an authority still more recent, Professor Prestwich, which is now passing through the press. In it (pp. 80, 81) I find the following seniority assigned to the orders which I here name :

1. Plants (cryptogamous)
2. Fishes
3. Birds
4. Mammals
5. Man

It will now, I hope, be observed that, according to the probable intention of the Mosaic writer, these five orders enumerated by him correspond with the state of geological knowledge, presented to us by the most recent authorities, in this sense ; that the origins of these orders respectively have the same succession as is assigned in Genesis to those representatives of the orders, which alone were probably known to the experience of Adamic man. My fourfold succession thus grows into a fivefold one. By placing before the first plant-life the Azoic period, it becomes sixfold. And again by placing before this the principal stages of the cosmogony, it becomes, according as they are stated, nine or tenfold ; every portion holding the place most agreeable to modern hypothesis and modern science respectively.

I now notice the points in which, so far as I understand, the text of the Proem, as it stands, is either incomplete or at variance with the representations of science :

1. It does not notice the great periods of invertebrate life standing between (1) and (2) of my last enumeration.

2. It also passes by the great age of Reptiles, with their antecessors the *Amphibia*, which come between (2) and (3). The secondary or Mesozoic period, says the Manual (i. 511), "has often been termed the age of Reptiles."

3. It mentions plants in terms which, as I understand from Professor Huxley and otherwise, correspond with the later, not the earlier, forms of plant-life.

4. It mentions reptiles in the same category with its mammals.

Now, as regards the first two heads, these omissions, enormous with reference to the scientific record, are completely in harmony with the probable aim of the Mosaic writer, as embracing only the formation of the objects and creatures with which early man was conversant. The introduction of these orders, invisible and unknown, would have been not agreeable, but injurious, to his purpose.

As respects the third, it will strike the reader of the Proem that plant-life (verses 11, 12) is mentioned with a particularity which is not found in the accounts of the living orders ; nor in the second notice of the Creation, which appears, indeed, pretty distinctly to refer to recent plant-life (Gen. ii., 5, 8, 9). Questions have been raised as to the translation of these passages, which I am not able to solve. But I bear in mind the difficulties which attend both oral traditions and the conservation of ancient MS., and I am not in any

way troubled by the discrepancy before us, if it be a discrepancy, as it is the general structure and effect of the Mosaic statement on which I take my stand.

With regard to reptiles, while I should also hold by my last remark, the case is different. They appear to be mentioned as contemporary with mammals, whereas they are of prior origin. But the relative significance of the several orders evidently affected the method of the Mosaic writer. Agreeably to this idea, insects are not named at all. So reptiles were a family fallen from greatness; instead of stamping on a great period of life its leading character, they merely skulked upon the earth. They are introduced, as will appear better from the LXX than from the A.V. or R.V., as a sort of appendage to mammals. Lying outside both the use and the dominion of man, and far less within his probable notice, they are not wholly omitted like insects, but treated apparently in a loose manner as not one of the main features of the picture which the writer meant to draw. In the Song of the Three Children, where the four principal orders are recited after the series in Genesis, reptiles are dropped altogether, which suggests either that the present text is unsound, or, perhaps more probably, that they were deemed a secondary and insignificant part of it. But, however this case may be regarded, of course I can not draw from it any support to my general contention.

I distinguish, then, in the broadest manner, between Professor Huxley's exposition of certain facts of science, and his treatment of the Book of Genesis. I accept the first, with the reverence due to a great teacher from the meanest of his hearers, as a needed correction to myself, and a valuable instruction for the world. But, subject to that correction, I adhere to my proposition respecting the fourfold succession in the Proem; which further I extend to a fivefold succession respecting life, and to the great stages of the cosmogony to boot. The five origins, or first appearances of plants, fishes, birds, mammals and man, are given to us in Genesis in the order of succession, in which they are also given by the latest geological authorities.

It is, therefore, by attaching to words a sense they were never meant to bear, and by this only, that Mr. Huxley establishes the parallel (so to speak), from which he works his heavy artillery. Land-population is a phrase meant by me to describe the idea of the Mosaic writer, which I conceive to be that of the animals familiarly known to early man. But, by treating this as a scientific phrase, it is made to include extinct reptiles, which I understand Mr. Huxley (*P. S. M.* p. 453) to treat as being land-animals; as, by taking birds of a very high formation, it may be held that mammal forms existed before such birds were produced. These are artificial contradictions, set up by altering in its essence one of the two things which it is sought to compare.

If I am asked whether I contend for the absolute accordance of

the Mosaic writer, as interpreted by me, with the facts and presumptions of science, as I have endeavored to extract them from the best authorities, I answer that I have not endeavored to show either that any accordance has been demonstrated, or that more than a substantial accordance—an accordance in principal relevant particulars—is to be accepted as shown by probable evidence.

In the cosmogony of the Proem, which stands on a distinct footing as lying wholly beyond the experience of primitive man, I am not aware that any serious flaw is alleged; but the nebular hypothesis with which it is compared appears to be, perhaps from the necessity of the case, no more than a theory; a theory, however, long discussed, much favored, and widely accepted in the scientific world.

In the geological part, we are liable to those modifications or displacements of testimony which the future progress of the science may produce. In this view its testimony does not in strictness pass, I suppose, out of the category of probable into that of demonstrative evidence. Yet it can hardly be supposed that careful researches, and reasonings strictly adjusted to method, both continued through some generations, have not in a large measure produced what has the character of real knowledge. With that real knowledge the reader will now have seen how far I claim for the Proem to Genesis, fairly tried, to be in real and most striking accordance.

And this brings me to the point at which I have to observe that Mr. Huxley, I think, has not mastered, and probably has not tried to master, the idea of his opponent as to what it is that is essentially embraced in the idea of a Divine revelation to man.

So far as I am aware, there is no definition, properly so called, of revelation either contained in Scripture or established by the general and permanent consent of Christians. In a word polemically used, of indeterminate or variable sense, Professor Huxley has no title to impute to his opponent, without inquiry, anything more than it must of necessity convey.

But he seems to assume that revelation is to be conceived of as if it were a lawyer's parchment, or a sum in arithmetic, wherein a flaw discovered at a particular point is *ipso facto* fatal to the whole. Very little reflection would show Professor Huxley that there may be those who find evidences of the communication of Divine knowledge in the Proem to Genesis as they read it in their Bibles, without approaching to any such conception. There is the uncertainty of translation; translators are not inspired. There is the difficulty of transcription; transcribers are not inspired, and an element of error is inseparable from the work of a series of copyists. How this works in the long courses of time we see in the varying texts of the Old Testament, with rival claims not easy to adjust. Thus the authors of the recent Revision* have had to choose in the Massoretic text itself between

* Preface to the Old Testament, p. vi.

different readings, and "in exceptional cases" have given a preference to the Ancient Versions. Thus, upon practical grounds quite apart from the higher questions concerning the original composition, we seem at once to find a human element in the sacred text. That there is a further and larger question, not shut out from the view even of the most convinced and sincere believers, Mr. Huxley may perceive by reading, for example, Coleridge's "Confessions of an Inquiring Spirit." The question whether this Proem bears witness to a Divine communication, to a working beyond that of merely human faculties in the composition of the Scriptures, is essentially one for the disciples of Bishop Butler; a question, not of demonstrative, but of probable evidence. I am not prepared to abandon, but rather to defend, the following proposition. It is perfectly conceivable that a document penned by the human hand, and transmitted by human means, may contain matter questionable, uncertain, or even mistaken, and yet may by its contents as a whole present such πίστεις, such moral proofs of truth Divinely imparted, as ought irrefragably *pro tanto* to command assent and govern practice. A man may possibly admit something not reconciled, and yet may be what Mr. Huxley denounces as a Reconciler.

I do not suppose it would be feasible, even for Professor Huxley, taking the nebular hypothesis and geological discovery for his guides, to give, in the compass of the first twenty-seven verses of Genesis, an account of the cosmogony, and of the succession of life in the stratification of the earth, which would combine scientific precision of statement with the majesty, the simplicity, the intelligibility, and the impressiveness of the record before us. Let me modestly call it, for argument's sake, an approximation to the present presumptions and conclusions of science. Let me assume that the statement in the text as to plants, and the statement of verses 24, 25 as to reptiles, can not in all points be sustained; and yet still there remain great unshaken facts to be weighed. First, the fact that such a record should have been made at all. Secondly, the fact that, instead of dwelling in generalities, it has placed itself under the severe conditions of a chronological order, reaching from the first *nisus* of chaotic matter to the consummated production of a fair and goodly, a furnished and a peopled world. Thirdly, the fact that its cosmogony seems, in the light of the nineteenth century, to draw more and more of countenance from the best natural philosophy; and fourthly, that it has described the successive origins of the five great categories of present life, with which human experience was and is conversant, in that order which geological authority confirms. How came these things to be? How came they to be, not among Accadians, or Assyrians, or Egyptians, who monopolized the stores of human knowledge when this wonderful tradition was born; but among the obscure records of a people who, dwelling in Palestine for twelve hundred years from

their sojourn in the valley of the Nile, hardly had force to stamp even so much as their name upon the history of the world at large, and only then began to be admitted to the general communion of mankind when their Scriptures assumed the dress which a Gentile tongue was needed to supply? It is more rational, I contend, to say that these astonishing anticipations were a God-given supply, than to suppose that a race, who fell uniformly and entirely short of the great intellectual development* of antiquity, should here not only have equaled and outstripped it, but have entirely transcended, in kind even more than in degree, all known exercise of human faculties.

Whether this was knowledge conveyed to the mind of the Mosaic author, I do not presume to determine. There has been, in the belief of Christians, a profound providential purpose, little or variously visible to us, which presided, from Genesis to the Apocalypse, over the formation of the marvelous compound, which we term the Holy Scriptures. This we wonderingly embrace without being much perplexed by the questions which are raised on them; for instance, by the question, In what exact relation the books of the Apocrypha, sometimes termed deutero-canonical, stand to the books of the Hebrew Canon. Difficulties of detail, such as may (or ultimately may not) be found to exist in the Proem to Genesis, have much the same relation to the evidence of revealed knowledge in this record, as the spots in the sun to his all-unfolding and sufficing light. But as to the Mosaic writer himself, all I presume to accept is the fact that he put upon undying record, in this portion of his work, a series of particulars which, interpreted in the growing light of modern knowledge, require from us, on the whole, as reasonable men, the admission that we do not see how he could have written them, and that in all likelihood he did not write them, without aid from the guidance of a more than human power. It is in this guidance, and not necessarily or uniformly in the consciousness of the writer, that, according to my poor conception, the idea of Revelation mainly lies.

And now one word on the subject of Evolution. I can not follow Mr. Huxley in his minute acquaintance with Indian sages, and I am not aware that Evolution has a place in the greater number of the schools of Greek philosophy. Nor can I comprehend the rapidity with which persons of authority have come to treat the Darwinian hypothesis as having reached the final stage of demonstration. To the eye of a looker-on their pace and method seem rather too much like a steeplechase. But this may very well be due to their want of appropriate knowledge and habits of thought. For myself, in my loose and uninformed way of looking at Evolution, I feel only too

* I write thus bearing fully in mind the unsurpassed sublimity of much that is to be found in the Old Testament. The consideration of this subject would open a wholly new line of argument, which the present article does not allow me to attempt.

much biased in its favor, by what I conceive to be its relation to the great argument of design.*

Not that I share the horror with which some men of science appear to contemplate a multitude of what they term "sudden" acts of creation. All things considered, a singular expression: but one, I suppose, meaning the act which produces, in the region of nature, something not related by an unbroken succession of measured and equable stages to what has gone before it. But what has equality or brevity of stage to do with the question how far the act is creative? I fail to see, or indeed am somewhat disposed to deny, that the short stage is less creative than the long, the single than the manifold, the equable than the jointed or graduated stage. Evolution is, to me, series with development. And like series in mathematics, whether arithmetical or geometrical, it establishes in things an unbroken progression; it places each thing (if only it stand the test of ability to live) in a distinct relation to every other thing, and makes each a witness to all that have preceded it, a prophecy of all that are to follow it. It gives to the argument of design, now called the teleological argument, at once a wider expansion, and an augmented tenacity and solidity of tissue. But I must proceed.

I find Mr. Huxley asserting that the things of science, with which he is so splendidly conversant, are "susceptible of clear intellectual comprehension" (*P. S. M.* p. 459). Is this rhetoric, or is it a formula of philosophy? If the latter, will it bear examination? He pre-eminently understands the relations between those things which Nature offers to his view; but does he understand each thing in itself, or *how* the last term but one in an evolutional series passes into and becomes the last? The seed may produce the tree, the tree the branch, the branch the twig, the twig the leaf or flower; but can we understand the slightest mutation or growth of Nature in itself? can we tell *how* the twig passes into leaf or flower, one jot more than if the flower or leaf, instead of coming from the twig, came directly from the tree or from the seed?

I can not but trace some signs of haste in Professor Huxley's assertion that, outside the province of science (*ibid.*), we have only imagination, hope, and ignorance. Not, as we shall presently see, that he is one of those who rob mankind of the best and highest of their inheritance, by denying the reality of all but material objects. But the statement is surely open to objection, as omitting or seeming to omit from view the vast fields of knowledge only probable, which are not of mere hope, nor of mere imagination, nor of mere ignorance;

* "Views like these, when formulated by religious instead of scientific thought, make more of Divine Providence and fore-ordination, than of Divine intervention; but perhaps they are not the less theistical on that account." (From the very remarkable Lectures of Professor Asa Gray on *Natural Science and Religion*, p. 77. Scribner, New York, 1880.)

which include alike the inward and the outward life of man; within which lie the real instruments of his training, and where he is to learn how to think, to act, to be.

I will now proceed to notice briefly the last page of Professor Huxley's paper, in which he drops the scientist and becomes simply the man. I read it with deep interest, and with no small sympathy. In touching upon it, I shall make no reference (let him forgive me the expression) to his "damnatory clauses," or to his harmless menace, so deftly conveyed through the prophet Micah, to the public peace.

The exaltation of Religion as against Theology is at the present day not only so fashionable, but usually so domineering and contemptuous, that I am grateful to Professor Huxley for his frank statement (p. 459) that Theology is a branch of science; nor do I in the smallest degree quarrel with his contention that Religion and Theology ought not to be confounded. We may have a great deal of Religion with very little Theology; and a great deal of Theology with very little Religion. I feel sure that Professor Huxley must observe with pleasure how strongly practical, ethical, and social is the general tenor of the three synoptic Gospels; and how the appearance in the world of the great doctrinal Gospel was reserved to a later stage, as if to meet a later need, when men had been toned anew by the morality and, above all, by the life of our Lord.

I am not, therefore, writing against him, when I remark upon the habit of treating Theology with an affectation of contempt. It is nothing better, I believe, than a mere fashion; having no more reference to permanent principle than the mass of ephemeral fashions that come from Paris have with the immovable types of Beauty. Those who take for the burden of their song "Respect Religion, but despise Theology," seem to me just as rational as if a person were to say "Admire the trees, the plants, the flowers, the sun, moon, or stars, but despise Botany, and despise Astronomy." Theology is ordered knowledge; representing in the region of the intellect what religion represents in the heart and life of man. And this religion, Mr. Huxley says a little further on, is summed up in the terms of the prophet Micah (vi. 8): "Do justly, and love mercy, and walk humbly with thy God." I forbear to inquire whether every addition to this—such, for instance, as the Beatitudes—is (*N. C.* p. 460) to be proscribed. But I will not dispute that in these words is conveyed the true ideal of religious discipline and attainment. They really import that identification of the will which is set out with such wonderful force in the very simple words of the "Paradiso"—

In la sua volontade è nostra pace,

and which no one has more beautifully described than (I think) Charles Lamb: "He gave his heart to the Purifier, his will to the Will that governs the universe." It may be we shall find that Christianity itself is in some sort a scaffolding, and that the final building is a pure and

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perfect theism: when * the kingdom shall be "delivered up to God," "that God may be all in all." Still, I can not help being struck with an impression that Mr. Huxley appears to cite these terms of Micah, as if they reduced the work of religion from a difficult to a very easy performance. But look at them again. Examine them well. They are, in truth, in Cowper's words—

> Higher than the heights above,
> Deeper than the depths beneath.

Do justly, that is to say, extinguish self; love mercy, cut utterly away all the pride and wrath, and all the cupidity, that make this fair world a wilderness; walk humbly with thy God, take His will and set it in the place where thine own was used to rule. "Ring out the old, ring in the new." Pluck down the tyrant from his place; set up the true Master on His lawful throne.

There are certainly human beings, of happy composition, who mount these airy heights with elastic step, and with unbated breath.

> Sponte suâ, sine lege, fidem rectumque colebat.†

This comparative refinement of nature in some may even lead them to undervalue the stores of that rich armory, which Christianity has provided to equip us for our great life-battle. The text of the prophet Micah, developed into all the breadth of St. Paul and St. Augustine, is not too much—is it not often all too little?—for the needs of ordinary men.

I must now turn, by way of epilogue, to Professor Max Müller; and I hope to show him that on the questions which he raises we are not very far apart. One grievous wrong, indeed, he does me in (apparently) ascribing to me the execrable word "theanthromorphic" (*N. C.* p. 920), of which I wholly disclaim the paternity, and deny the use. Then he says, I warn him not to trust too much to etymology (p. 921). Not so. But only not to trust to it for the wrong purpose, in the wrong place: just as I should not preach on the virtue and value of liberty to a man requiring handcuffs. I happen to bear a name known, in its genuine form, to mean stones or rocks frequented by the gled; and probably taken from the *habitat* of its first bearer. Now, if any human being should ever hereafter make any inquiry about me, trace my name to its origin, and therefore describe the situation of my dwelling, he would not use etymology too much, but would use it ill. What I protest against is a practice, not without example, of taking the etymology of mythologic names in Homer, and thereupon supposing that in all cases we have thus obtained a guide to their Homeric sense. The place of Nereus in the mind of the poet is indisputable; and here etymology helps us. But when a light-etymology is found for Hera, and it is therefore asserted

* 1 Cor. xv. 24, 28.

† Ovid, "Metam." i. 90.

that in Homer she is a light-goddess, or when, because no one denies that *Phoibos* is a light-name, therefore the Apollo of Homer was the Sun, then indeed, not etymology, but the misuse of etymology, hinders and misleads us. In a question of etymology, however, I shall no more measure swords with Mr. Max Müller than with Mr. Huxley in a matter of natural science, and this for the simple reason that my sword is but a lath. I therefore surrender to the mercy of this great philologist the derivation of *dine* and *dîner* from *déjeuner;* which may have been suggested by the use of the word *dine* in our Bible (as John xxi. 12) for breakfasting; a sense expressed by La Bruyère (xi.) in the words, *Cliton n'a jamais eu, toute sa vie, que deux affaires, qui sont de dîner le matin, et de souper le soir.*

But, Mr. Max Müller says, I have offended against the fundamental principles of comparative mythology (*N. C.* p. 919). How, where, and why, have I thus tumbled into mortal sin? By attacking solarism. But what have I attacked, and what has he defended? I have attacked nothing but the exclusive use of the solar theory to solve all the problems of the Aryan religions; and it is to this monopolizing pretension that I seek to apply the name of solarism, while admitting that "the solar theory has a most important place" in solving such problems (*N. C.* p. 704). But my *vis-à-vis*, whom I really can not call my opponent, declares (*N. C.* p. 919) that the solarism I denounce is not his solarism at all; and he only seeks to prove that "certain portions of ancient mythology have a directly solar origin." So it proves that I attack only what he repudiates, and I defend what he defends. That is, I humbly subscribe to a doctrine, which he has made famous throughout the civilized world.

It is only when a yoke is put upon Homer's neck, that I presume to cry "hands off." The Olympian system, of which Homer is the great architect, is a marvelous and splendid structure. Following the guidance of ethnological affinities and memories, it incorporates in itself the most diversified traditions, and binds them into an unity by the plastic power of an unsurpassed creative imagination. Its dominating spirit is intensely human. It is therefore of necessity thoroughly anti-elemental. Yet, when the stones of this magnificent fabric are singly eyed by the observer, they bear obvious marks of having been appropriated from elsewhere by the sovereign prerogative of genius; of having had an anterior place in other systems; of having belonged to Nature-worship, and in some cases to Sun-worship; of having been drawn from many quarters, and among them from those which Mr. Max Müller excludes (p. 921): from Egypt, and either from Palestine, or from the same traditional source, to which Palestine itself was indebted. But this is not the present question. As to the solar theory, I hope I have shown either that our positions are now identical, or that, if there be a rift between them, it is so narrow that we may conveniently shake hands across it.—*Nineteenth Century.*

ANIMAL WEATHER-LORE.

By CHARLES C. ABBOTT, M. D.

HAPPILY there still remain a few of those great, cavernous, open fireplaces, flanked by high-backed settles, whereon the young people love to lounge, while their elders, resting from the day's labors, talk drowsily of old times, recount the adventures of their youth, and repeat the tales of their grandfathers. As one of such young people, I have passed many long winter evenings, listening eagerly to what the septuagenarians might relate, and occasionally venturing a question or two, that more light might be thrown upon obscure portions of remarks made at the time. Then, particularly, are we likely to hear much of that very curious animal weather-lore that, for the past two centuries, has been handed down from father to son. Time and again, as the weather chanced to be discussed, I have heard some uncouth rhyme repeated, usually prefaced with the remark, "You know the old saying."

That all animals are more or less affected by coming atmospheric changes is unquestionable. This simple fact has been recognized the world over, but, unlike many other simple facts, has not resulted in leading to any important discoveries. It has, however, given rise to the innumerable sayings to which I have referred.

Inasmuch as the animal weather-lore current in England and Sweden dates far prior to the settlement of this country by the Swedes and English, it would seem probable that such sayings as now are or recently were current in South and Central New Jersey are merely adaptations of English and Swedish weather-lore to our fauna, just as the European names of the commoner birds found there were applied to those American species most closely resembling them; and so, any rhyme or brief saying referring to them would be applied to the analogous bird found here. This is eminently reasonable, for, if the given habit, voice, or other peculiarity of a European bird did, or was supposed to, indicate a given meteorological condition, the same rule should hold good in America. As a matter of fact, however, I can find no similarity between the English and Swedish and the American weather-lore, except such as applies to domestic animals; nor do I find any common English sayings in use.

That which I have heard, and have recorded from time to time, appears to have originated where now, or where it lately was, in use. To a great extent, I believe it to be original with the descendants of the immigrants that settled Central New Jersey and the country generally about Philadelphia; but a portion of it, very possibly, was derived from the Indians.

At present, a portion of this weather-lore is repeated as nursery

rhymes, and it is due to this that it has been preserved to the present time; and, so far as I have been able to determine, not one of the rhymes or sayings has ever been published. That among the earliest papers and almanacs of the country there may be found some of them, or slightly different versions of the same, is probable, but my searchings therefor, in the larger libraries, have not resulted in any such discoveries.

The main interest, however, in connection with weather-lore, is to determine whether they do or do not correctly represent the relationship of the animals mentioned to the given condition of the weather. In other words, is the zoölogy of the weather-lore misrepresented or not? I am forced to declare that, as a rule, those who by virtue of their ingenuity framed these rhymes and brief sayings did not correctly interpret Nature.

Very many of the early English settlers were, no doubt, excellent observers; but they appear, at times, to have more desired to be looked upon as weather-prophets than as naturalists, and strove to have glib nonsense-sayings pass current as evidence of their wisdom, instead of taking pains to correctly interpret the course of Nature and determine the relation of animal life to its environment.

Often, during my rambles in the neighborhood, I have questioned the few remaining descendants of the original settlers concerning the local weather-proverbs, and I find the impression is still prevalent that the purport of all these sayings is substantially correct, and therefore, to a great degree, that my neighbors are laboring under erroneous impressions. "Is there not wisdom in a multitude of counselors?" they ask; and I, standing alone, am voted the fool, while they pose as sages.

Let us consider this weather-lore, bit by bit, as I have gathered it from time to time, and discuss its merits, if it possesses any, and also its absurdities.

Of such sayings as refer to our domestic animals, the following are the most noteworthy. Of the cow, I have heard it said:

> "When a cow tries to scratch its ear,
> It means a shower is very near";

and again—

> "When it thumps its ribs with its tail,
> Look out for thunder, lightning, hail."

As is now pretty well known, a short time before a shower in summer, there is often a highly electrical condition of the atmosphere, which makes all animals more or less uneasy. Therefore, the lashing of the tail, if not merely to brush away flies, may refer to this uneasiness, and so, too, the ears may be more sensitive than the general surface of the body. This is a probable explanation, but, after all, it is not proved that the cow at such a time suffers as much from it as is supposed; nor is it easy to see how the flagellation of a very insignifi-

cant part of the body can ease a painful sensation common to the entire surface. On the other hand, it is certain that flies and other troublesome insects are sensitive to atmospheric changes, even a slight lowering of the temperature, such as no mammal would appreciate; and for an hour or two before a shower, for this reason, they congregate in extraordinary numbers about animals—horses and cows particularly. I have thought that they seek the cows for warmth when the air suddenly cools; and is it not more than probable that the nervousness on the part of the animal, shown by frantic efforts to scratch its ears with its hind-feet and the lashing of its tail, has to do with the excess of irritation caused by innumerable flies, and not with any unusual electrical titillation? If so, the cow's action is still indicative of an approaching change in the weather, and so far may be claimed as a sign of such change, but the connection of the two facts is not such a one as is usually given. It is an indirect, not direct, indication of the prophesied rain-storm. But bearing heavily on the subject is the unquestionable fact that an unusual number of flies often suddenly make their appearance, and torment cattle almost beyond endurance, during the four or six weeks of drought which in summer, early or late, we are so sure to have. In such cases the signs fail. I have asked many a farmer how this could be, and the one reply that I have received in every case is that "there was a shower in the neighborhood." It usually happened, however, that the neighborhood was as parched as we were, and, seeing the signs fail with them, they were covetous of the shower they supposed that we had had. Perhaps it is with such indications of changes in the weather as it has been said of autumnal proofs of the character of the approaching winter. Miles Overfield once remarked, "When the signs get to failin' 'long in the fall, there'll be no tellin' about the winter."

Of pigs, I have heard it said, very frequently—

> "When swine carry sticks,
> The clouds will play tricks";

but that—

> "When they lie in the mud,
> No fears of a flood."

The first of these couplets is of twofold interest. I have watched them for years, to see what purport this carrying of sticks and bunches of grass might have, and have only learned that it has nothing whatever to do with the weather, or at least with coming rain-storms. The drought of summer is so far a convenience as to throw light upon this habit, as it did upon the uneasy cows. Pigs carry sticks as frequently then as during wet weather, or just preceding a shower. Furthermore, these gathered twigs are not brought together as though to make a nest, but are scattered about in a perfectly aimless manner. For some cause, the animal is uneasy, and takes this curious method of relieving itself. The probabilities are that it is a survival of some

habit common to swine in their feral condition, just as we see a dog turn about half a dozen times before lying down.

In an interesting paper on local weather-lore, read by Mr. Amos W. Butler before the American Association for the Advancement of Science, during the Philadelphia meeting of 1884, the author has another version of this saying: "When hogs gather up sticks and carry them about, expect cold weather." This is wholly at variance with what I have observed, for my memoranda record this habit almost wholly during the hot weather, and this must necessarily be the rule with New Jersey swine, or the local weather-prophets would not have coined the verse as I have given it.

As to the other couplet, it is about as near meaningless as any saying can well be. Some rustic rhymer, a century ago, may have added it as a piece of fun, but it has stuck most persistently. As it stands now, it has stood for quite one hundred years.

In reference to the dog, I have heard the following more pretentious stanza, which has now taken its place among our nursery rhymes, where, indeed, it is best fitted to remain:

"When drowsy dogs start from their sleep,
And bark at empty space,
'Tis not a dream that prompts them to,
But showers come on apace."

Here we have essentially the same inference as in that of the rhyme about cows, but it is not to be explained away so readily. Such acts, as described, can not be attributed to annoyance by flies, for they too often emerge from dark quarters, where they have been unmolested; but the all-important fact must not be overlooked that such acts are not confined to summer. If they were, the electrical theory might be advanced with some confidence. From what I have noticed in such dogs as I have owned, the habit of dreaming, which in the rhyme is denied to be the explanation, is probably the key to the mystery. Again, statistics show that the correspondence between such habits and sudden showers is only what we should expect in the way of coincidences. Dogs certainly are not to be considered as reliable barometers.

The same may be said of the domestic cat. Its movements have all been carefully noted, and the yawning, stretching, scratching, and waving of the tail appear to have been accredited with some special meteorological significance. Careful observation has not confirmed any of these impressions. Table-legs are scratched time and again by Tom or Tabby, and no rain falls for twenty-four or forty-eight hours. They stretch themselves after a nap, lick their sides and wash their faces with the same regularity in midwinter as in midsummer, yet it is only showers, and not snow-storms, which these actions are supposed to predict.

When in summer the signs fail, my country friends conveniently

forget the remark they have made; but, if the day does prove showery, my non-combative neighbors take much delight in repeating over and over again, "I told thee so," with a suggestive emphasis, showing how much, like other people, they love to gain a victory, if open warfare can be avoided.

The only weather-rhyme referring to a cat that I have heard, and which is essentially the same as that about dogs, runs thus:

> "When Tabby claws the table-legs,
> She for a summer shower begs."

That is, begs it will hurry; with no doubt in her mind of its possibly disappointing her.

The weather-lore of the commoner wild animals is of much more general interest. Weather-sayings referring to animals do not appear to have been so numerous as are those referring to birds. I have been able to learn of but three examples. In reference to minks and weasels, I have heard it said—and possibly others may be familiar with this mystic rhyme—

> "When storm-winds blow and night is black,
> The farmer may a pullet lack;
> But, if the moon is shining clear,
> No mink or weasel dares come near."

This involves an interesting phase of the life-history of these animals; for while they probably can see a little when it is quite dark, and are safely guided by the sense of smell, nevertheless, the experience of trappers about home proves that they do wander about during moonlight nights. Indeed, on careful inquiry, it seems that the trapper generally anticipates better success during the moonlit nights than when it is very dark. I strongly suspect that the truth lies in the fact that, when it is dark and stormy, the watchful house-dog is not on the alert, and thus the cunning weasel or mink is free to raid upon the poultry-house and feast upon the pullet that it seizes. How my neighbors will take to this explanation I can only surmise. Like other people, they fight vigorously for the opinions they have cherished through life. The musk-rat and gray squirrels have given rise to many trite sayings, and have long been looked upon as weather-prophets, but that they are nothing of the sort I have elsewhere* endeavored to show.

The following may or may not be a local saying:

> "When flying-squirrels run on ground,
> The clouds'll pass you by, be bound."

What this may mean has been a question with me for a long time. It is a common remark, either in this or a simpler form, and many, who have little faith in pigs or dogs as weather-prophets, build largely

* "Rambles about Home," p. 73, D. Appleton & Co., New York, 1884.

upon the habits of the flying-squirrel. The saying itself implies that a drought exists at the time that these animals frequent the ground rather than the trees, coming, of course, thereto, in order to find food. If the saying be true, the summer food of the flying-squirrel must be more plentiful on the ground than in the tops of the tallest trees. What that food is exactly, I am not aware; nor have I had any opportunity to verify the statement that flying-squirrels frequent the ground during "dry spells." Those that I have seen, near home, are so strictly crepuscular that only the initial movements of their nocturnal journeys are readily traced; but, whenever I have seen them sally from their retreats, it was to take a tree-top route for several rods and then to be lost to sight. Take the year through, it is probable that they seldom come to the ground to forage. When they do so, is it an evidence of continued dry weather? I can neither contradict nor affirm; but are not the probabilities against such being the case?

Speaking of the opossum, it is said that, if found in autumn in hollow trees, the winter will be milder than if occupying a burrow in the ground.

This seems to be very reasonable, and would pass admirably as a weather-sign, but for one unfortunate circumstance. While you may find one or more in a tree, your neighbor may find as many in the ground. I have known this to be the case more than once. Under these circumstances, meet your neighbor at the line-fence and compare notes. What about the winter?

From their greater abundance and never-failing presence, it might be thought that the weather-lore of birds would be much more elaborate than that referring to other classes of animals; but my observations do not confirm this. There are simply a greater number of sayings current, and fully one half are too trivial to repeat. It would seem as if a weather-lore possibly of Indian origin and referring to birds then abundant, but now wholly wanting, was current more than a century ago. These sayings were subsequently applied to other species, nearly or more remotely allied, and whatever meaning they may originally have had has been lost; but the apparent absurdity of such "proverbs," as now used, seems never to have occurred to those who repeat them.

That the dusting of chickens, cackling of geese, and the "pot-racking" of Guinea-hens have not given rise to an elaborate series of weather-proverbs is, I think, surprising. The only familiar reference to the chicken heard about home is that the rooster, crowing at night, says, "Christmas—coming—on!" It does appear that the midnight crowing of cocks is more frequently heard in December than in June; but, so far as the meaning is concerned, it unfortunately happens that the nocturnal crowing is as often heard in January as in December. Calling attention to this, I was once gravely assured that the cocks

crew differently then, and said, "Christmas—come—and—gone!" I accepted the explanation. This is not a weather matter, but is not irrelevant, as it shows how very common it once was to couple any unusual occurrence with something sooner or later to happen, and therefore, in the matter of weather especially, to claim it as prophetic of that event.

Of the examples of weather-lore of birds, the following are not uncommonly heard in Central New Jersey. Of the cardinal-grossbeak, or winter redbird, it is said:

> "The redbird lies, without regret:
> However dry, it whistles 'wet!'"

That is, the bird is credited with knowing it will not rain, and teases the farmer by singing "wet" in his ears all day. Others put another meaning on the redbird's note, and claim it to be a sure sign of rain. This is more like the ordinary sayings commonly heard, and let us give it a moment's consideration. At present, the time of year when the cardinal-birds sing least is during the hot summer months. Not that they are absolutely mute for even a few days at a time, but relatively so as compared with their joyous strains through autumn and winter; and again, early in summer, when they are nesting, these birds, like robins, are more apt to sing directly after a shower than at any other time.

So much for the gay cardinal as a weather-prophet. The rare summer redbird—a tanager—which also utters a whistling note, well described by the syllable "wet," shortly and sharply expressed, is likewise said to prophesy rain. The probabilities are that the note of the redbird, cardinal and summer, suggesting the word "wet," has given rise to the belief that their utterance was a sign of a coming shower or storm. It is often by such illogical methods that these sayings have become established. After a few repetitions they become fixed in the mind and their origin forgotten; they are invested with an importance not their due, and not attributed to them by their originators. Ultimately they are incorporated in the weather-lore of the country.

Of the innumerable swallows, it is said, with as little show of reason:

> "No rain e'er poured upon the earth,
> That damped the twittering swallow's mirth."

No? Well, of late, the whole host takes refuge from storms—the barn-swallows in the hay-mow, the cliff-swallows under the eaves, the sand-martins in their burrows, and the chimney-swifts in their sooty homes in the chimneys. Why this change of habit? For a wonderful change must have taken place, if the couplet quoted was ever true. I do admit that swallows and swifts appear to be noisier before and during a shower; but does not this arise from the fact that at such a time they collect in great numbers near their nests, to take refuge,

if the storm should increase in violence? And again, the silence of other birds makes the twittering swallow a more prominent bird than under other circumstances; but nothing of this warrants the extravagant assertion that no storm ever put a quietus upon them.

The larger hawks, too, are supposed to give warning of a coming shower when they utter their peculiar cat-like scream. Among our old people the following may sometimes be heard repeated:

> "The hen-hawk's scream, at hot, high noon,
> Foretells a coming shower soon."

This couplet is of some interest, as, at present, it is not applicable to our larger hawks and buzzards. Indeed, the only one of them that is prone to cry out while circling overhead is the red-tailed buzzard or hen-hawk, and this bird is very seldom seen in midsummer, and now certainly is only heard in autumn, winter, or early spring. The saying implies that formerly these birds were abundant at all times of the year, and during the summer would cry out in their peculiar fashion. The settlement of the country and general deforesting of such a large portion of it have driven these hawks to more retired parts during the nesting-season, and there, throughout summer, their cry may indicate that it will soon rain; but, if so, why does not the same cry in autumn have some reference to the weather?

It is scarcely necessary to continue the list. Other birds than those mentioned—reptiles, batrachians, and fishes—have all given rise to certain current sayings, but of no more value than those I have given, and all, I think, based upon illogical inferences. Snakes are claimed as excellent barometers; but the habits upon which the belief rests are those that characterize every day of the creature's life. Toads and frogs are largely depended upon, but a careful record for a single season will show how little they are to be trusted; and even the fishes can not disport themselves in summer, but straightway the clouds must open upon us, a tornado visit us, or premature frosts balk the calculations of the farmer.

Curiously enough, I do not find that insect-life has entered to any important extent into the weather-lore of this neighborhood. Contradictory remarks are often made as to ant-hills: thus, when they are very high, it will be a dry day; others insist that it is evidence that it will soon rain. Spiders' webs, also, are variously held as of barometric value; but a careful record of several summers contradicts this emphatically. The positions of the paper-hornets' nests, which in autumn are often prominent objects in the country after the foliage drops, are variously asserted to be indicative of a "hard" or "open" winter, as they chance to be placed in the upper or lower branches of a tree. My skepticism as to the value of this sign arises from the fact that there is, as might be expected, no uniformity in the positions of any half-dozen such nests.

It may be rash to say that meteorological science can gain nothing from scientific observation of animal life; but the character of the weather-lore that has been handed down from father to son for the past two centuries plainly indicates that the observations which gave rise to them were anything but scientific in character. Mankind now, as formerly, may be close observers of Nature, but this does not imply that they are accurate observers. They assume as correct the appearance, but it is no unusual circumstance for an animal to be doing the very opposite of what might naturally be supposed was the case. The simple and sad fact derived from a study of local animal weather-lore is that, in the days of our grandfathers, painstaking naturalists were few and far between.

JAPANESE HOUSE-BUILDING.*

By Professor EDWARD S. MORSE.

THE first sight of a Japanese house—that is, a house of the people—is certainly disappointing. From the infinite variety and charming character of their various works of art, as we had seen them at home, we were anticipating new delights and surprises in the character of the house; nor were we on more intimate acquaintance to be disappointed. As an American, familiar with houses of certain types, with conditions among them signifying poverty and shiftlessness, and other conditions signifying refinement and wealth, we were not competent to judge the relative merits of a Japanese house.

The first sight, then, of a Japanese house is disappointing; it is unsubstantial in appearance, and there is a meagerness of color. Being unpainted, it suggests poverty; and this absence of paint, with the gray and often rain-stained color of the boards, leads one to compare it with similar unpainted buildings at home—and these are usually barns and sheds in the country, and the houses of the poorer people in the city. With one's eye accustomed to the bright contrasts of American houses, with their white, or light, painted surfaces; rectangular windows, black from the shadows within, with glints of light reflected from the glass; front door with its pretentious steps and portico; warm red chimneys surmounting all, and a general trimness of appearance outside, which is by no means always correlated with like conditions within—one is too apt at the outset to form a low estimate of a Japanese house. An American finds it difficult indeed to

* From "Japanese Homes and their Surroundings." By Edward S. Morse, Director of the Peabody Academy of Science; late Professor of Zoölogy, University of Tokio, Japan; Member of the National Academy of Science; Fellow of the American Academy of Arts and Sciences, etc. With Illustrations by the Author. Boston: Ticknor & Co. 1886.

consider such a structure as a dwelling, when so many features are absent that go to make up a dwelling at home—no doors or windows such as he had been familiar with; no attic or cellar; no chimneys, and within no fireplace, and of course no customary mantel; no permanently inclosed rooms; and, as for furniture, no beds or tables, chairs or similar articles—at least, so it appears at first sight.

One of the chief points of difference in a Japanese house, as compared with ours, lies in the treatment of partitions and outside walls. In our houses these are solid and permanent, and, when the frame is built, the partitions form part of the framework. In the Japanese house, on the contrary, there are two or more sides that have no permanent walls. Within, also, there are but few partitions which have similar stability; in their stead are slight sliding-screens, which run in appropriate grooves in the floor and overhead. These grooves mark the limit of each room. The screens may be opened by sliding them back, or they may be entirely removed, thus throwing a number of rooms into one great apartment. In the same way the whole side of a house may be flung open to sunlight and air. For communication between the rooms, therefore, swinging-doors are not necessary. As a substitute for windows, the outside screens, or *shōji*, are covered with white paper, allowing the light to be diffused through the house.

Where external walls appear they are of wood unpainted, or painted black, and, if of plaster, white or dark slate-colored. In certain classes of building the outside wall, to a height of several feet from the ground, and sometimes even the entire wall, may be tiled, the interspaces being pointed with white plaster. The roof may be either lightly shingled, heavily tiled, or thickly thatched. It has a moderate pitch, and, as a general thing, the slope is not so steep as in our roofs. Nearly all the houses have a veranda, which is protected by the widely overhanging eaves of the roof, or by a light supplementary roof projecting from beneath the eaves.

While most houses of the better class have a definite porch and vestibule, or *genka*, in houses of the poorer class this entrance is not separate from the living-room; and, since the interior of the house is accessible from two or three sides, one may enter it from any point. The floor is raised a foot and a half or more from the ground, and is covered with thick straw mats, rectangular in shape, of uniform size, with sharp, square edges, and so closely fitted that the floor upon which they rest is completely hidden. The rooms are either square or rectangular, and are made with absolute reference to the number of mats they are to contain. With the exception of the guest-room, few rooms have projections or bays. In the guest-room there is at one side a more or less deep recess divided into two bays by a slight partition; the one nearest the veranda is called the *tokonoma*. In this place hang one or more pictures, and upon its floor, which is slightly raised above the mats, rests a flower-vase, incense-burner, or some

other object. The companion bay has shelves and a low closet. Other rooms also may have recesses to accommodate a case of drawers or shelves. Where closets and cupboards occur, they are finished with sliding screens instead of swinging-doors. In tea-houses of two stories the stairs, which often ascend from the vicinity of the kitchen, have beneath them a closet, and this is usually closed by a swinging-door.

In city houses the kitchen is at one side or corner of the house, generally in an L, covered with a pent-roof. This apartment is often toward the street, its yard separated from other areas by a high fence. In the country the kitchen is nearly always under the main roof. In the city few out-buildings, such as sheds and barns, are seen. Accom-

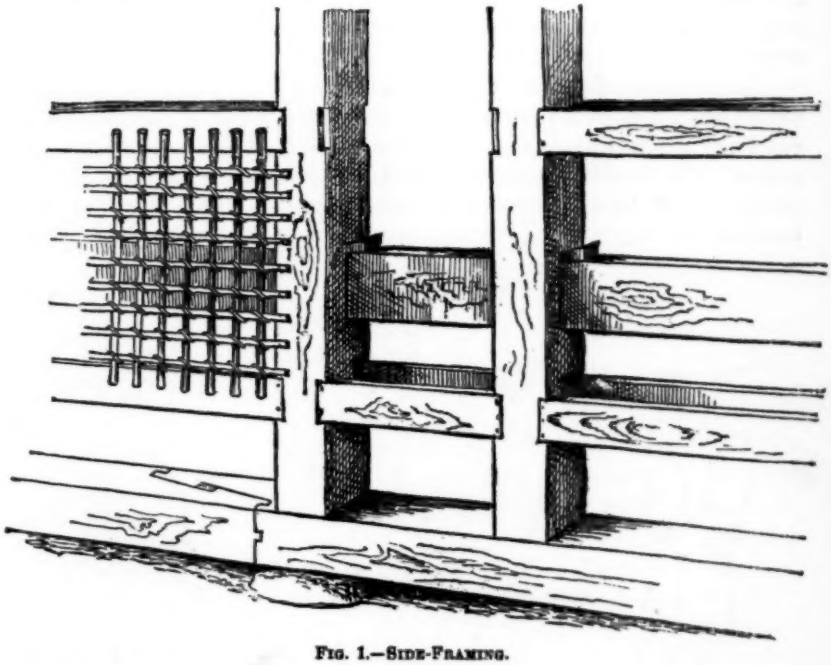

FIG. 1.—SIDE-FRAMING.

panying the houses of the better class are solid, thick-walled, one or two storied, fire-proof buildings called *kura*, in which the goods and chattels are stored away at the time of a conflagration. These buildings, which are known to the foreigners as "godowns," have one or two small windows and one door, closed by thick and ponderous shutters. Such a building usually stands isolated from the dwelling, though often in juxtaposition; and sometimes, though rarely, it is used as a domicile.

In the gardens of the better classes summer-houses and shelters of rustic appearance and diminutive proportions are often seen. Rustic arbors are also to be seen in the larger gardens. Specially constructed houses of quaint design and small size are not uncommon; in these

the ceremonial tea-parties take place. High fences, either of board or bamboo, or solid walls of mud or tile with stone foundations, surround the house or inclose it from the street. Low rustic fences border the gardens in the suburbs. Gateways of various styles, some of imposing design, form the entrances; as a general thing they are either rustic and light, or formal and massive.

Whatever is commonplace in the appearance of the house is toward the street, while the artistic and picturesque face is turned toward the garden, which may be at one side or in the rear of the house—usually in the rear. Within these plain and unpretentious houses there are often to be seen marvels of exquisite carving and the perfection of cabinet-work; and surprise follows surprise as one becomes more fully acquainted with the interior finish of these curious and remarkable dwellings.

The framework of an ordinary Japanese dwelling is simple and primitive in structure; it consists of a number of upright beams which run from the ground to the transverse beams and inclines of the roof above. The vertical framing is held together either by short strips, which are let into appropriate notches in the uprights to which the bamboo lathing is fixed, or by longer strips of wood, which pass

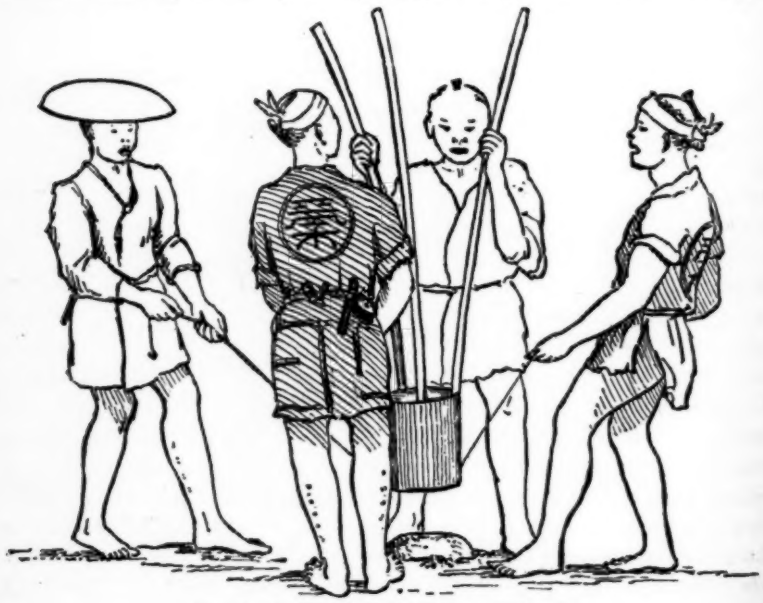

FIG. 2.—POUNDING DOWN FOUNDATION-STONES.

through mortises in the uprights, and are firmly keyed or pinned into place (Fig. 1). In larger houses these uprights are held in position by a framework near the ground. There is no cellar or excavation beneath the house, nor is there a continuous stone foundation as with us. The uprights rest directly, and without attachment, upon single uncut

or rough-hewed stones, these in turn resting upon others, which have been solidly pounded into the earth by means of a huge wooden maul worked by a number of men (Fig. 2). In this way the house is perched upon these stones, with the floor elevated at least a foot and a half or two feet above the ground. In some cases the space between the uprights is boarded up; this is generally seen in Kioto houses. In others the wind has free play beneath; and, while this exposed condition renders the house much colder and more uncomfortable in winter, the inmates are never troubled by the noisome air of the cellar, which too often infects our houses at home. Closed wooden fences of a more solid character are elevated in this way; that is, the lower rail or sill of the fence rests directly upon stones placed at intervals apart of six or eight feet. The ravages of numerous ground-insects, as well as larvæ, and the excessive dampness of the ground at certain seasons of the year, render this method of building a necessity.

The accurate way in which the base of the uprights is wrought to fit the inequalities of the stones upon which they rest is worthy of notice. In the emperor's garden we saw a two-storied house finished in the most simple and exquisite manner. It was, indeed, like a beautiful cabinet, though disfigured by a bright-colored foreign carpet upon its lower floor. The uprights of this structure rested on large, oval, beach-worn stones buried endwise in the ground; and, upon the smooth rounded portions of the stones, which projected above the level of the ground to a height of ten inches or more, the uprights had been most accurately fitted (Fig. 3). The effect was extremely light and buoyant, though apparently insecure to the last degree; yet this building had not only withstood a number of earthquake-shocks, but also the strain of severe typhoons, which during the summer months sweep over Japan with such violence. If the building be very small, then the frame consists of four corner-posts running to the roof. In dwellings having a frontage of two or more rooms, other uprights occur between the corner-posts. As the rooms increase in number through the house, uprights come in the corners of the rooms, against which the sliding-screens, or *fusuma*, abut. The passage of these uprights through the room to the roof above gives a solid constructive appearance to the house. When a house has a veranda—and nearly every

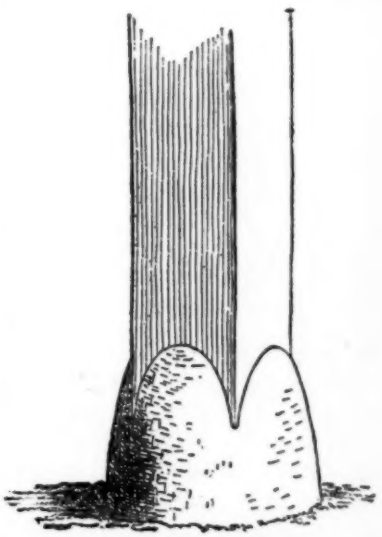

FIG. 3.—FOUNDATION-STONE.

house possesses this feature on one or more of its sides—another row of uprights starts in a line with the outer edge of the veranda. Unless the veranda be very long, an upright at each end is sufficient to support the supplementary roof which shelters it. These uprights support a cross-beam, upon which the slight rafters of the supplementary roof rest. This cross-beam is often a straight unhewed stick of timber, from which the bark has been removed. Indeed, most of the horizontal framing-timbers, as well as the rafters, are usually unhewed—the rafters often having the bark on, or perhaps being accurately squared sticks; but, in either case, they are always visible as they project from the sides of the house, and run out to support the overhanging eaves. The larger beams and girders are but slightly hewed; and it is not unusual to see irregular-shaped beams worked into the construction of a frame, often for their quaint effects (Fig. 4), and in many cases as a matter of economy.

For a narrow house, if the roof be a gable, a central upright at each end of the building gives support to the ridge-pole from which

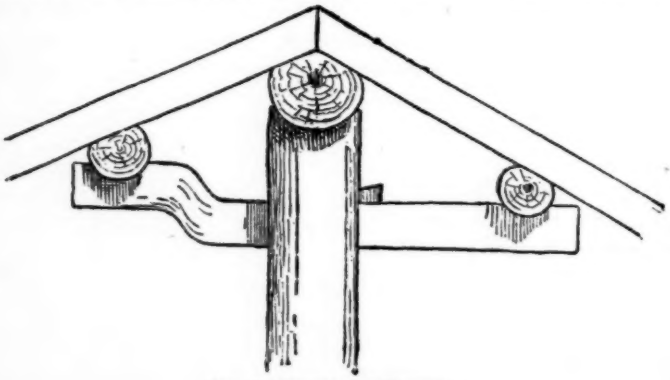

FIG. 4.—SECTION OF FRAMING.

the rafters run to the eaves. If the building be wide, a transverse beam traverses the end of the building on a level with the eaves, supported at intervals by uprights from the ground; and upon this short uprights rest, supporting another transverse beam above, and often three or more tiers are carried nearly to the ridge. Upon these supports rest the horizontal beams which run parallel with the ridge-pole, and which are intended to give support to the rafters (Fig. 5).

In the case of a wide gable-roof there are many ways to support the frame, one of which is illustrated in the following outline (Fig. 6). Here a stout stick of timber runs from one end of the house to the other on a vertical line with the ridge-pole, and on a level with the eaves. This stick is always crowning, in order to give additional strength. A few thick uprights start from this to support the ridge-pole above; from these uprights beams run to the eaves; these are mortised into the uprights, but at different levels on either side, in

order not to weaken the uprights by the mortises. From these beams run short supports to the horizontal rafters above.

The roof, if it be of tile or thatch, represents a massive weight—the tiles being thick and quite heavy, and always bedded in a thick

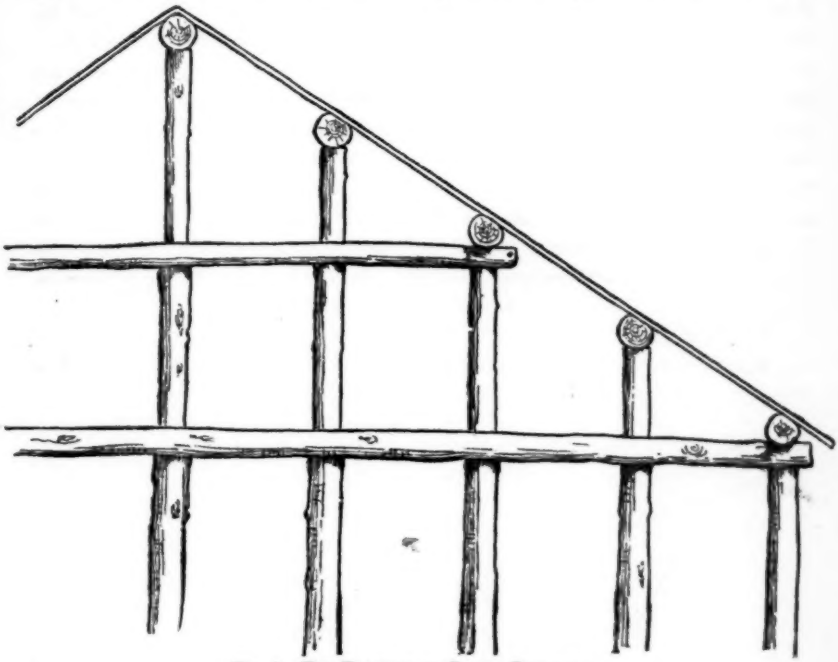

FIG. 5.—END-FRAMING OF LARGE BUILDING.

layer of mud. The thatch, though not so heavy, often becomes so after a long rain. The roof-framing, consequently, has oftentimes to support a great weight; and, though in its structure looking weak, or at least primitive in design, yet experience must have taught the Jap-

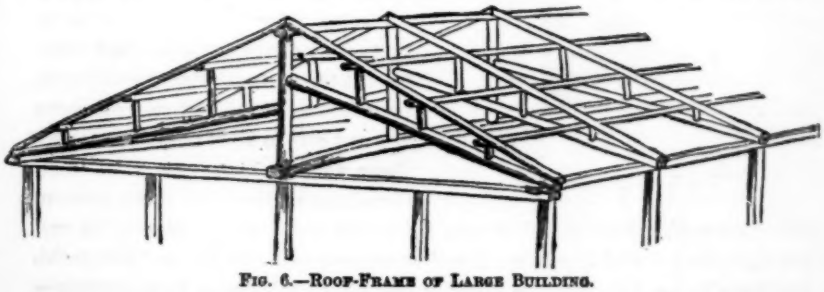

FIG. 6.—ROOF-FRAME OF LARGE BUILDING.

anese carpenters that their methods were not only the simplest and most economical, but that they answered all requirements. One is amazed to see how many firemen can gather upon such a roof without its yielding. I have seen massive house-roofs over two hundred years

old, and other frame structures of a larger size and of far greater age, which presented no visible signs of weakness. Indeed, it is a very unusual sight to see a broken-backed roof in Japan.

Diagonal bracing in the framework of a building is never seen. Sometimes, however, the uprights in a weak frame are supported by braces running from the ground at an acute angle, and held in place by wooden pins. Outside diagonal braces are sometimes met with as an ornamental feature. In the province of Ise one often sees a brace or bracket made out of an unhewed piece of timber, generally the proximal portion of some big branch. This is fastened to an upright, and appears to be a brace to hold up the end of a horizontal beam that projects beyond the eaves. These braces, however, are not even notched into the upright, but held in place by square wooden pins, and are of little use as a support for the building, though answering well to hold fishing-rods and other long poles, which find here convenient lodgment (Fig. 7).

The framework of a building is often revealed in the room in a way that would delight the heart of an Eastlake. Irregularities in the form of a stick are not looked upon as a hindrance in the construction of a building. From the way such crooked beams are brought into use, one is led to believe that the builder prefers them. The desire for rustic effects leads to the selection of odd-shaped timber. Fig. 4 represents the end of a room, wherein is seen a crooked cross-piece passing through a central upright, which sustains the ridge-pole.

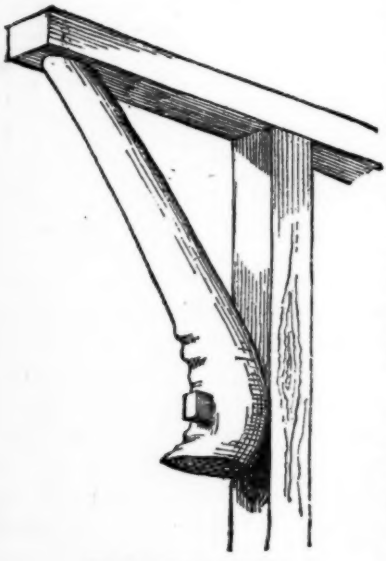

Fig. 7.—Outside Brace.

As the rooms are made in sizes corresponding to the number of mats they are to contain, the beams, uprights, rafters, flooring-boards, boards for the ceiling, and all strips are got out in sizes to accommodate these various dimensions. The dimensions of the mats from one end of the empire to the other are approximately three feet wide and six feet long; and these are fitted compactly on the floor. The architect marks on his plan the number of mats each room is to contain—this number defining the size of the room; hence, the lumber used must be of definite lengths, and the carpenter is sure to find these lengths at the lumber-yard. It follows from this that but little waste occurs in the construction of a Japanese house.

The permanent partitions within the house are made in various ways. In one method bamboo strips of various lengths take the place of laths. Small bamboos are first nailed in a vertical position to the wooden strips, which are fastened from one upright to another; narrow strips of bamboo are then secured across these bamboos by means of coarse cords of straw, or bark-fiber (Fig. 1). This partition is not unlike our own plaster-and-lath partition. Another kind of partition may be of boards; and against these small bamboo rods are nailed quite close together, and upon this the plaster is put. Considerable pains are taken as to the plastering. The plasterer brings to the house samples of various-colored sands and clays, so that one may select from these the color of his wall. A good coat of plaster comprises three layers. The first layer, called *shita-nuri*, is composed of mud, in which chopped straw is mixed; a second layer, called *chu-nuri*, of rough lime, mixed with mud; the third layer, called *uwa-nuri*, has the colored clay or sand mixed with lime—and this last layer is always applied by a skillful workman.

Many of the partitions between the rooms consist entirely of light sliding-screens. Often two or more sides of the house are composed entirely of these simple and frail devices. The outside permanent walls of a house, if of wood, are made of thin boards nailed to the frame horizontally—as we lay clapboards on our houses. These may be more firmly held to the house by long strips nailed against the boards vertically. The boards may also be secured to the house vertically, and weather-strips nailed over the seams—as is commonly the way with certain of our houses. In the southern provinces a rough house-wall is made of wide slabs of bark, placed vertically, and held in place by thin strips of bamboo nailed crosswise. This style is common among the poorer houses in Japan; and, indeed, in the better class of houses it is often used as an ornamental feature, placed at the height of a few feet from the ground.

Outside plastered walls are also very common, though not of a durable nature. This kind of wall is frequently seen in a dilapidated condition. In Japanese picture-books this broken condition is often shown, with the bamboo slats exposed, as a suggestion of poverty.

In the cities the outside walls of more durable structures, such as warehouses, are not infrequently covered with square tiles, a board wall being first made, to which the tiles are secured by being nailed at their corners. These may be placed in diagonal or horizontal rows—in either case an interspace of a quarter of an inch being left between the tiles, and the seams closed with white plaster, spreading on each side to the width of an inch or more, and finished with a rounded surface. This work is done in a very tasteful and artistic manner, and the effect of the dark-gray tiles crossed by these white bars of plaster is very striking (Fig. 8).

The Japanese dwellings are always of wood, usually of one story

and unpainted. Rarely does a house strike one as being specially marked or better looking than its neighbors; more substantial, certainly, some of them are, and yet there is a sameness about them which becomes wearisome. Particularly is this the case with the long, uninteresting row of houses that border a village street; their picturesque

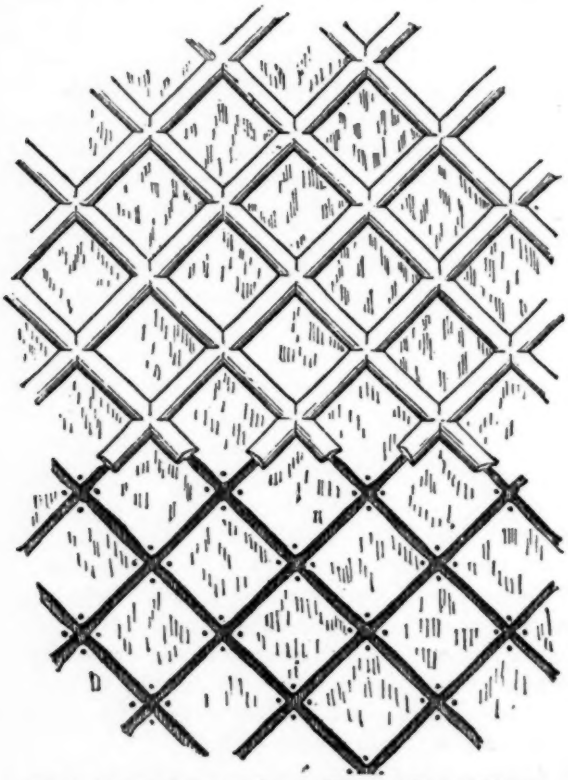

FIG. 8.—ARRANGEMENT OF SQUARE TILES ON SIDE OF HOUSE.

roofs alone save them from becoming monotonous. A closer study, however, reveals some marked differences between the country and city houses, as well as between those of different provinces.

The country house, if anything more than a shelter from the elements, is larger and more substantial than the city house, and, with its ponderous thatched roof and elaborate ridge, is always picturesque. One sees much larger houses in the north—roofs of grand proportions and an amplitude of space beneath, that farther south occurs only under the roofs of temples. We speak now of the houses of the better classes, for the poor farm-laborer and fisherman, as well as their prototypes in the city, possess houses that are little better than shanties, built, as a friend has forcibly expressed it, of "chips, paper, and straw." But even these huts, clustered together as they oftentimes are in the

larger cities, are palatial in contrast to the shattered and filthy condition of a like class of tenements in many of the cities of Christian countries.

In traveling through the country the absence of a middle class, as indicated by the dwellings, is painfully apparent. It is true that you

FIG. 9.—STREET IN KANDA KU, TOKIO.

pass, now and then, large comfortable houses with their broad thatched roofs, showing evidences of wealth and abundance in the numerous *kura* and out-buildings surrounding them; but, where you find one of these, you pass hundreds which are barely more than shelters for their

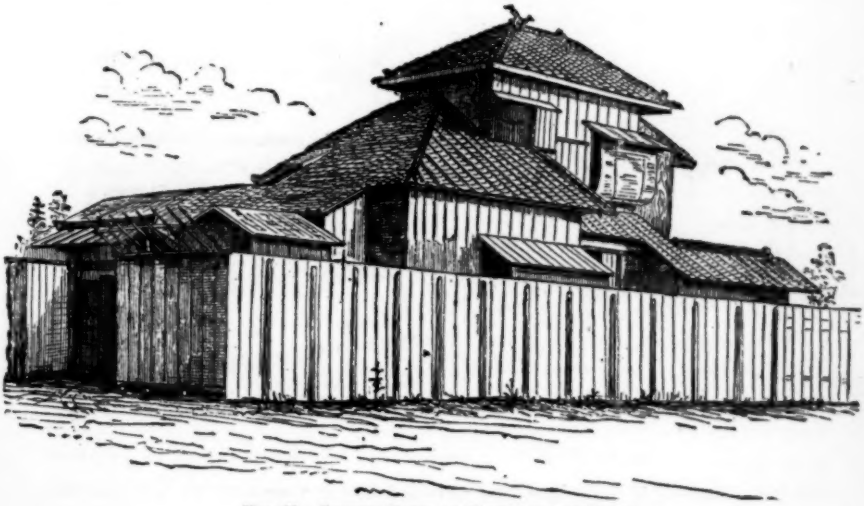

FIG. 10.—STREET VIEW OF DWELLING IN TOKIO.

inmates, and, within the few necessary articles render the evidences of poverty all the more apparent.

Though the people that inhabit such shelters are very poor, they appear contented and cheerful notwithstanding their poverty. Other

classes, who, though not poverty-stricken, are yet poor in every sense of the word, occupy dwellings of the simplest character. Many of the dwellings are often diminutive in size; and, as one looks in at a tiny cottage containing two or three rooms at the most, the entire house hardly bigger than a good-sized room at home, and observes a family of three or four persons living quietly and in a cleanly manner in this limited space, he learns that in Japan, at least, poverty and constricted quarters are not always correlated with coarse manners, filth, and crime.

The accompanying sketch (Fig. 9) represents a group of houses bordering a street in Kanda Ku, Tokio. The windows are in some cases projecting or hanging bays, and are barred with bamboo or square bars of wood. A sliding-screen, covered with stout white paper, takes the place of our glass-windows. Through these gratings the inmates of the house do their bargaining with the street venders. The entrance to these houses is usually by means of a gate common to a number. This entrance consists of a large gate used for vehicles and heavy loads, and by the side of this is a smaller gate used by the people. Sometimes the big gate has a large square opening in it, closed by a sliding-door or grating—and through this the inmates have ingress and egress.

FIG. 11.—VIEW OF DWELLING FROM GARDEN, IN TOKIO.

The houses, if of wood, are painted black; or else, as is more usually the case, the wood is left in its natural state, and this gradually turns to a darker shade by exposure. When painted, a dead black is used; and this color is certainly agreeable to the eyes, though the heat-rays caused by this black surface become almost unendurable on hot days, and must add greatly to the heat and discomfort within the

house. With a plastered outside wall the surface is often left white, while the framework of the building is painted black—and this treatment gives it a decidedly funereal aspect.

The sketch shown in Fig. 10 is a city house of one of the better classes. The house stands on a new street, and the lot on one side is vacant; nevertheless, the house is surrounded on all sides by a high board-fence—since, with the open character of a Japanese house, privacy, if desired, can be secured only by high fences or thick hedges. The house is shown as it appears from the street. The front door is near the gate, which is shown on the left of the sketch. There is here no display of an architectural front; indeed, there is no display anywhere. The largest and best rooms are in the back of the house; and what might be called a back-yard, upon which the kitchen opens, is parallel with the area in front of the main entrance to the house, and separated from it by a high fence. The second story contains one room, and this may be regarded as a guest-chamber. Access to this chamber is by means of a steep flight of steps, made out of thick plank, and unguarded by hand-rail of any kind. The roof is heavily tiled, while the walls of the house are outwardly composed of broad thin boards, put on vertically, and having strips of wood to cover the joints. A back view of this house is shown in Fig. 11. Here all the rooms open

FIG. 12.—OLD FARM-HOUSE IN KABUTOYAMA.

directly on the garden. Along the veranda are three rooms *en suite*. The balcony of the second story is covered by a light supplementary roof, from which hangs a bamboo screen to shade the room from the sun's rays. Similar screens are also seen hanging below.

The veranda is quite spacious; and in line with the division between the rooms is a groove for the adjustment of a wooden screen or

shutter when it is desired to separate the house into two portions temporarily. At the end of the veranda, to the left of the sketch, is the latrine. The house is quite open beneath, and the air has free circulation.

The country house of an independent *samurai*, or rich farmer, is large, roomy, and thoroughly comfortable. I recall with the keenest pleasure the delightful days enjoyed under the roof of one of these typical mansions in Kabutoyama, in the western part of the province of Musashi. The residence consisted of a group of buildings shut in from the road by a high wall. Passing through a ponderous gateway, one enters a spacious court-yard, flanked on either side by long, low buildings, used as store-houses and servants' quarters. At the farther end of the yard, and facing the entrance, was a comfortable old farm-house, having a projecting gable-wing to its right (Fig. 12). The roof was a thatched one of unusual thickness. At the end of the wing was a triangular latticed opening, from which thin blue wreaths of smoke were curling. This building contained a few rooms, including an unusually spacious kitchen. The kitchen opened directly into a larger and unfinished portion of the house, having the earth for its floor, and used as a wood-shed. The owner informed me that the farm-house was nearly three hundred years old. To the left of the building was a high wooden fence, and, passing through a gateway, one came into a smaller yard and garden. In this area was another house quite independent of the farm-house; this was the house for guests. Its conspicuous feature consisted of a newly-thatched roof, surmounted by an elaborate and picturesque ridge—its design derived from temple architecture. Within were two large rooms opening upon a narrow veranda. These rooms were unusually high in stud, and the mats and all the appointments were most scrupulously clean. Communication with the old house was by means of a covered passage. Back of this dwelling, and some distance from it, was still another house, two stories in height, and built in the most perfect taste; and here lived the grandfather of the family—a fine old gentleman, dignified and courtly in his manners.

THE INFLUENCE OF INVENTIONS UPON CIVILIZATION.

By CHAUNCEY SMITH.

[*Concluded.*]

THE relation between astronomical and mathematical investigations and navigation has been long recognized, but this relation is dependent upon the observation of the apparent position of heavenly bodies at given times, and these observations are in turn dependent upon telescopes and upon clocks and chronometers, both modern inventions.

The working of the railroads of the country is hardly less dependent upon the time-keepers we possess than navigation is upon chronometers. Let any one ask himself how the railroads of this country could be operated if our only time-keepers were sun-dials, hour-glasses, and the clepsydras of the ancients, and he will soon see that the construction of the time-tables of our railroads and the operation of the roads in conformity with them would be impossible.

Mr. Atkinson will tell us what it costs to transport a barrel of flour upon our railroads from Minneapolis to Boston, and approximately what the saving is by the railroads over the old modes of transportation, but can he tell us what part of that saving is to be credited to the clocks at the railroad-stations and to the watches which the conductors carry in their pockets?

The late Judge Curtis said to me several years ago that the introduction of railroads had made a great change in the habits of the people as to punctuality in keeping appointments; that before their introduction nobody thought of being punctual to a minute, or even to an hour. Nobody thought of being "on time" till the railroads presented the alternative of being so or of "getting left."

One can now easily see that before the general use of clocks and watches, punctuality, as it is now understood among business-men, could hardly have been reckoned as a duty. This is one illustration out of many more important ones where our social or moral obligations have arisen from or have been changed by physical inventions. By observations upon the laws or conditions of health by means of recent inventions and only possible by their means, we have learned how to counteract or prevent the introduction or spread of many diseases, and in consequence of this, men recognize the duty to adopt and enforce many regulations in society for which no reason could be found a few years ago.

How could we live without glass? It enters so largely into the list of things we consider absolutely necessary, to say nothing of its uses for convenience or luxury, that we should almost as soon think of living without light or heat, without air or water, as to live without this cheap substance made principally out of the sand under our feet. Can any one tell what civilization would be without it? It would certainly be a very different thing from what it is.

We talk of the fireside and the influence it has upon families and social life, but the window plays a more important part in our homes than the fireside. The invention of glass goes back to a very early period, but its general use for windows is comparatively recent. Accustomed as we are to glass windows, it is difficult for us to conceive how a house could be lived in with comfort without it.

There is another use of glass, resting upon a very simple invention, which plays a very important part in the comfort of man and the

value of his labor, and which contributes wonderfully to our knowledge of nature and the universe.

Ever since man was capable of observing things around him, he must often have seen that a straight stick thrust obliquely into the water appeared to be bent at its surface. It was a long time before man learned the value of this fact; but at length the lens was discovered. The invention consisted simply in the form given to a piece of glass; in giving to one or both of the surfaces of a disk of glass a curved form. This we know forms a lens, and a lens has become one of the most valuable devices known to man, but it was a long time after its invention before it became of much value.

A thousand years elapsed after the invention of the lens before it assumed an important place among the instruments employed by man. But man learned its value at last. Lenses may be made of other materials than glass, but for all practical purposes they are made of glass, and no other material will supply its place.

I alluded to spectacles as a valuable invention. I have never seen any attempt to estimate its value. I do not know that I ever heard the inquiry made. And yet when we remember that nearly every person above the age of forty-five, and very many below that age, use glasses, we see that they must enter largely into the sum of our comforts. How many persons would be deprived of the pleasures and benefits of reading and writing during a large portion of their lives but for this simple invention! How many kinds of labor would be performed badly and with great discomfort but for these devices! At what disadvantage literary labor would be carried on without them! For how many delicate handicrafts would men and women become unfitted in their later years but for them! At what discomfort and inconvenience would domestic needlework be performed in their absence! How much trial of the patience is saved by their use! I doubt not our tempers are much better in old age for these helps.

But the value of the invention of the lens is not limited to its use for spectacles. From it has grown up those wonderful modern instruments, the telescope and microscope. Through the former has come a large part of our astronomical knowledge, which has a great commercial value from the security it gives to man in navigating the oceans. It has also a high moral and mental value from the field it opens to the exercise and training of the powers of observation and imagination; from the new conceptions it has given us of the immensity of creation, and of the power which gave it birth. I wonder if any man can rise from a contemplation of the facts, the mysteries, and magnitudes of the universe, revealed to us by the telescope and spectroscope, without repeating to himself, with a new sense of its significance, the question, "What is man that Thou art mindful of him, or the son of man that Thou visitest him?"

But, while the lens thus opens up to man in the boundless regions

of space a universe which no stretch of the imagination could give him a glimpse of without it, it opens up to him also a no less wonderful universe in regions which, by reason of their littleness, lie equally beyond his powers of observation or the powers of his imagination.

It reveals to him the presence of life in forms as wonderful for their minuteness and activity and numbers as the sun and stars are for the mighty spaces they occupy and traverse.

This little device, then, of a piece of glass formed with curved surfaces, which a boy may fashion upon a piece of sandstone, not only enters into the daily use of man, ministering to his comfort and prolonging his power to work efficiently, but in no figurative sense it enables him to behold a new heaven and a new earth. It opens to him the most wonderful secrets of nature, and gives him new conceptions of the vastness of the universe and of the magnitude of the forces involved in its mechanism. The ancients believed that the sun was only a few miles away, a few thousand miles at most, but the telescope has enabled man to learn that the sun is 92,000,000 miles away from us; that the earth, 8,000 miles in diameter, in his yearly journey around it, travels 600,000,000 miles, at the rate of nearly twenty miles a second.

What conception of infinite power could the imagination, unaided, give to man, which could in the least approach that which is involved in this movement of the earth!

But we know through the telescope, that this power, mighty as it is, is but an infinitesimal part of that which is actually displayed in the regions of space which only within recent years and by the aid of a multitude of inventions have been opened to the observation of man.

Upon glass and the lens man is dependent for the use of another recent invention, which now that we have it we would not willingly do without.

A beautiful art has come into existence since I was a young man, which gratifies one of the strongest desires of the heart and ministers to the social pleasures of every family and circle of friends. I well remember when the newspaper first announced that a Frenchman had invented a way of taking pictures by the help of the sun. Before that time very few people could have likenesses of their friends, living or dead. The face of a friend could only be seen when he was present. When absent, memory must do what it could to preserve the features. Only the rich, and not a large proportion of them, could command portraits of themselves or friends. Into what houses will you now go where you do not expect to find likenesses of whole families, and whole circles of friends? Very poor indeed are those who can not and do not find the means of procuring and preserving pictures of those they love. Can any one measure the amount of gratification which the world has received from the practice of the wonderful art of taking pictures from nature, through the agency of a few chemicals spread upon a sheet of paper or of silver, and of the rays of light

concentrated by means of a lens? There has been received from it mental, artistic, and moral culture. The invention has opened up a new field of investigation and research to the labor of the chemist and to the student of nature. From the first announcement to the world, to the present hour, a host of inventors have been engaged in perfecting and improving the art, enlarging the field of its applications, and studying the laws of nature upon which it rests. The boundaries of human knowledge, in more than one department of physics, have been greatly extended in these efforts. Astronomy has received important aid from it, and by its help we get not merely pictures of what exists in the heavenly regions, but records of what is there taking place.

This art has even come to play an important part in the administration of justice and in the protection of the community against crime. By its aid criminals are detected, watched, and convicted. Forgeries are proved or disproved by its use. It finds an important place in the ordinary business of commerce and the mechanic arts. By its aid, copies or representations of all valuable works of art are placed within the reach of multitudes who, otherwise, would know nothing of them or know them only through inadequate verbal description. The improvement of the public taste in relation to art, by the knowledge of works of art which has been thus diffused, has been very great.

Does any one doubt that this extension and this spread of knowledge of the works of art must tend to the improvement of man's moral nature? Can it be doubted that the social affections are quickened by the preservation of the features of friends and the interchange among friends and families of pictures of those who make up the family circle? Will not a boy, absent from home, feel the influence of home more strongly when he looks upon the faces of parents or sisters, than he would if he could not thus bring them into his presence?

But all these benefits which the world reaps from photography have come to us from inventions. It is not the fruit so much of genius, as of that patient labor and research which is winning from Nature, day by day, secrets far more valuable to man than all her hidden treasures of gold and silver.

Within the memory of men not very old, a new power has, by the genius of inventors, been trained into the service of man. This power is electricity. It has always, as we now know, been present in many of the phenomena of nature, exhibiting itself most strikingly in the lightnings of the thunder-storm, revealing, as man believed, the presence of a mysterious power which might be destructive, but which never could be useful to man.

A trifling incident revealed to an observing man in Italy the fact that, when two metals and the leg of a frog were made to touch, the muscles of the leg were contracted. This was a little more than a hundred years ago. This led to the invention of the galvanic battery, an instrument by which man was enabled to generate electricity for his

own use. But many years were still to elapse before man could turn the instrument to much service.

Forty years later, another observer noticed that, when a wire which was carrying a current of electricity generated by a battery was placed near the needle of a compass, it turned the needle one way or the other on its pivot. A few years later, Faraday discovered that if such a wire was wound around a piece of soft iron, it made a magnet of the iron. Out of these simple facts have arisen the inventions of the telegraph, the telephone, and the electric light. The oldest of these inventions, the telegraph, is only about forty-five years old, and there are many who can easily remember the feelings of incredulity and amazement with which the claim that the invention had been made was received.

Can any one calculate the influence which this invention is destined to have upon the condition of man? We think it has spread over the world with wonderful rapidity. And so it has. But the world has just begun to use it. Although we see telegraph lines spread all over this country, and we say and think that everybody uses the telegraph, yet the number of messages sent last year did not much exceed one to each two persons in the land, while the number of letters written, including postal-cards, probably exceeded ten to each individual. When messages can be sent, as they most certainly will be, to any part of the land for ten cents or less, multitudes of people, who never think now of using the telegraph except upon matters of pressing importance, will use it upon the most common occasions. How many times would the simple "all well" be exchanged daily between friends if it could be done for five or ten cents!

A multitude of inventors have been necessary to make the telegraph what it is, and its improvement was never going on more rapidly than to-day. I well remember how difficult it was for many persons to form an idea, when the telegraph was first invented, of the way it worked. It was not an uncommon belief that the paper on which the message was written was in some way sent along the wire to its destination. But the idea became familiar after a little time that the electricity only traversed the line and operated a mechanism at the distant place which recorded the message in a new language, or delivered it directly to the ear, and people began to think that they understood how the telegraph was worked. But when inventors began to talk about sending two or three messages over the same wire, at the same time, the limit of belief seemed to have been reached, and people obstinately refused to believe that the thing could be done. But it has been done in more ways than one, and now there are numerous wires in the country over which four or even six messages are sent at the same time. As these inventions enable one wire to do the work of two or four or more, the wires which are wanting are called by the telegraph people "phantom-wires." The improvement of the tele-

graph is taking other directions. On the common lines the messages are sent by the operator at the rate of about thirty or forty words a minute. But inventions are in progress, and are now being introduced, which will enable a thousand words a minute to be sent. Think of sending messages from Boston to New York over one wire, and recording them there, at the rate of a thousand words a minute! Few people speak at the rate of two hundred words a minute.

Those of us who are in the habit of receiving messages, often get them printed on long strips of paper. The invention used in sending messages in that way is one which enables a man in New York, by touching keys like those of a piano, to operate a printing-machine in Boston or Chicago.

The highest achievements in telegraphy are undoubtedly reached in the ocean telegraph. It demanded a whole line of inventions peculiar to itself. A simple wire could not be used for a conductor. It would give out the electricity to the water so fast that none would reach the farther end to deliver the message, and the wire itself would be speedily destroyed. A coating must, therefore, be found for it which would at once protect the wire from the action of the water and keep the electricity from going off into the water. When such a coating had been invented, it was found necessary to strengthen the copper wire used for the conductor by the addition of steel wires, which must not touch the copper wire, but surround it, and this too must be protected by a coating. Then machinery had to be invented to combine the copper and steel wires with the coating material into a cable. Other machinery had to be invented to deliver the cable from a ship as she sailed over the course where the cable was to be laid. Only the steamship could be used for the purpose, and thus the invention of the steam-engine gave to man the power to establish ocean telegraphs. New instruments of the most wonderful sensibility had to be invented both for sending and receiving the messages. A minute magnet carries a tiny mirror and is suspended by a thread so as to yield to the slightest impulse. A ray of light from a lamp falls upon this mirror and is reflected upon a screen some feet distant. This ray of light is the finger which the operator watches upon the screen. As the current in the wire varies under the action of the sending instrument, the magnet turns one way or the other, and the spot of light on the screen moves one way or the other and indicates the signals of the Morse alphabet to the operator and enables him to spell out the words.

Sometimes a fault is developed in the wire as it lies on the bottom of the ocean, and signals can not be sent. Does it seem possible that man can tell whereabout on three thousand miles of wire, two miles under water, the fault is? He has invented instruments which enable him to do it, and to send a vessel to the very spot over the wire where the fault is, pick up the wire and mend it, and return it to its resting-place.

Some time before his death, in 1819, while resting from labor in his old age, James Watt, when asked to allow his fellow-citizens to honor him with a seat in Parliament, refused, saying that he had given employment to the better part of a million of men, and had earned the right to rest from work. To how many millions of men since then has his invention given employment! In a life of Watt published many years since I find a statement that the steam-power of the world was equal to that of 400,000,000 men, and this amount has probably been doubled since the statement was made. And yet the world has even now but just begun to reap the fruits of this invention. Each year witnesses the extension of its use.

About seventy years ago Robert Fulton, one of the greatest mechanical geniuses of this country, applied the steam-engine to a boat and made the first trial of a ship moved by the power of heat in a trip from New York to Albany. Now every ocean is plowed by the steamship, and there is hardly a navigable river on the face of the globe that has not become a highway for it. A few years later, in 1825, George Stephenson invented the locomotive and gave to man the railroad, and now, sixty years later, we have more than 128,000 miles of railroad in operation in this country alone.

I believe that no other Englishman has done so much for his fellow-men, so much to change the social and economical conditions of society, as George Stephenson.

Would you like to know how much the steam-engine has increased the power of man in Massachusetts? I can tell you what the locomotive has done. In 1878 the railroad companies of this State had 1,030 locomotives. The proportion due to the amount of their track in this State was 757, and the work they did was equal to what 913,545 horses could do on good common roads, and was equivalent to the labor of 5,481,270 laboring-men, or to that of a population of nearly 20,000,000.

Now, in 1875, Massachusetts had only about 130,000 horses, and her population was a little more than a million and a half.

But this was not all that Massachusetts owed to the steam-engine. She employs it largely in steam-vessels owned in the State or coming from abroad. What the whole amount of work done by these vessels was equal to I do not know, but it was large.

She also employed steam- and water-power in her manufactures equal to that of 1,912,488 men. The work done by the steam- and water-power was equal to what could have been done by hand-power by a population of 7,400,000.

I think there are more than 20,000 locomotives in the United States. There would be more than that if all the roads were as well provided with locomotives as the roads in Massachusetts are.

Assuming that to be the number, and that they do as much work as they do here, and the work is equal to that of 25,000,000 horses,

or to that of nearly 150,000,000 men, or to a population of nearly 500,000,000. I suppose the actual population of the United States is nearly 60,000,000. We see by this how much in this country alone the inventions of Watt and Stephenson have increased the powers of man. The imagination staggers under the figures.

Of course a host of other inventors have been concerned with the results I have given, but the results are none the less the work of inventors because there are many of them.

The steam-engine has entered into many other inventions, the steam-drill and the steam-dredge, for instance, which have given to man the ability to execute engineering works of the most extraordinary character.

The steam-hammer is another of the wonders of modern machinery which followed the steam-engine. One of the gods of ancient mythology was Vulcan, a blacksmith, who was supposed, I believe, to have forged the thunderbolts of Jupiter. What conception may have been entertained of his power or of the magnitude of thunderbolts, I can not say, but probably he was never supposed to wield a hammer like a modern steam-hammer, weighing thirty-five tons, through a distance of ten or twelve feet, or to have executed any work like the forging of the propeller-shaft of a modern steamship. But what ancient gods could not do the modern inventor easily does.

The power of the steam-engine comes from heat—from the fire in the boiler. The fuel used is largely coal, stored ages ago in the earth. Fire has been long known to man and has been ready to do his work, and the iron and steel for engines had been long known. But not till the magic of the inventor had brought these things together did man learn what power was lying ready to his hand.

If at the time Watt made his improvement in the steam-engine some change in the laws of Nature had come into play which had gradually increased the physical power of man until now it had become tenfold greater than it was, this increase would not be equal to that which man has gained from the labors of Watt and the inventors who have succeeded him in the development of that instrument, and in the invention and improvement of machines to be used in connection with it. And this increased power of man is not exerted for the rich alone, but is shared by the great mass of men as impartially as if the power of each individual had been increased, as I have supposed, in the same ratio. We see this most strikingly in the ability which the railroad and the telegraph have given to the laboring-men in the mechanical industries throughout the land to combine and organize for mutual support, and in opposition, as it is said, to capital. It is only through the agency of the railroad and the telegraph that a great body of laboring-men scattered over a wide area of territory are able to organize and act as a unit, and thus secure the highest prices for their labor which the nature of their work and the demands of society will permit. It is only by reason of the capital of others invested in these

recent inventions that laboring-men have acquired the power, which may be used either wisely or unwisely, to secure and exercise the strength which comes from union, and to deal with employers and capitalists on an equal footing, if not with the conditions in their favor.

Take another illustration:

One of the most simple transactions of our lives is to purchase a postal-card for one cent, write a communication on one side, and on the opposite side a direction to a correspondent in any part of the United States or Canada, and drop it into a box on a street corner. We have no further control over or agency in it; but we are perfectly assured that it will in no long time, within a week, even if its destination is San Francisco, be delivered to the correspondent. And, if we wish to write a long letter, we have only to add another cent and purchase a postage-stamp, for which a letter weighing one ounce may in like manner be sent and delivered. Now the ability to do this is shared by rich and poor alike, for there is hardly any depth of poverty which precludes any one from doing what I have described. But there is no step in the transaction, from the purchase of the stamp or card to the delivery to the correspondent, or in the antecedent conditions which make it possible, which is not an invention. I can not attempt to enumerate the inventions directly or indirectly involved, and I refer to the matter only as an illustration of the results which have been reached by invention in placing things highly important or desirable to men within the reach of all. It is not many years since the rates of postage in this country were so high, varying from six cents to twenty-five on each sheet, that a correspondence with distant friends involved an expense which could be but sparingly indulged by laboring-men, and was felt to be a burden by many in comfortable circumstances. The cost of sending a letter four hundred miles was equal to the price of half a day's work at the common monthly rate of wages of agricultural laborers. Now a letter may be sent ten times as far, at one twelfth the cost, and in less than one tenth the time.

A few years after Watt invented the steam-engine, and while he was laboring to improve it and adapt it to the various wants of the world, a wonderful military genius arose in Europe, who filled the world with his fame and made himself as large a place in history, perhaps, as any man ever did. He played havoc with the nations of Europe, changed the boundaries of countries and their forms of government, and apparently raised France to the highest pitch of power. But he lived to destroy. Measuring Bonaparte and Watt by their works and their works by the consequences which followed them, and which must stand as the greater fact in the history of the world? Which controlled most potently, for his own time and for the future, the destiny of nations, and which most deserves the admiration and homage, not to say gratitude, of mankind?

I hear people not infrequently express the belief that man will soon exhaust the field of invention. The inventions of the last century have been so numerous and wonderful that to many minds it seems most likely that man will soon reach the limit of his power, or that he will exhaust the resources of Nature. But there is little reason to fear that either condition can be reached for ages, if ever. It is as little likely that man will ever reach the limit of invention as it is that he will be able to fix the bounds of the universe. Man makes inventions by combining the materials and forces of Nature, so as to reach new results. Let any one consider how numerous are the materials which Nature presents to the observation and use of man, how varied in kind and degree are the forces which are in constant operation, and how multifarious and intricate are the laws which govern their actions and relations, and then calculate, if he can, the number of possible combinations which can be made. I have seen the statement, which is no doubt true, that the fifteen blocks in the gem-puzzle can be arranged in more than a million different ways. If this simple toy possesses such capabilities, what possibility is there that man can ever exhaust the field of Nature? Wonderful as man's inventions are in number and character, they are at an infinite distance behind the works of Nature. What a multitude of created things there are in Nature, looking simply at species and varieties, and not at the individuals! How many kinds of plants and animals are to be found! What multitudes of reptiles and insects! No machine which man has invented calls into play such wonderful forces or is governed by such wonderful laws as the humblest plant on which he treads! Man is far enough yet from inventing a structure which shall build itself up from the earth, air, and water, and scatter germs for its indefinite reduplication! He has succeeded in copying some of the products of Nature, and he will achieve still greater results, but in doing it he has but opened a new field of invention, one which only a few years before seemed utterly beyond his reach. He has enlarged the field of invention, not exhausted it. A striking instance of what man has done in this new direction is exhibited in the substance called alizarine. It is the substance which gives to madder its coloring quality. Not many years ago, madder was extensively cultivated in many countries to supply the demand for the arts. Now the article is made artificially from coal-tar, and the fields where madder was cultivated have to be devoted to other purposes. Invention has taught man how to make indigo, and the artificial article is likely to supplant the natural product. Diamonds have been produced artificially. I have full faith that sugar will in time in like manner be produced artificially. Starch and oil may not unlikely be provided in the same way. Man now cultivates the silk-worm which devours mulberry-leaves and converts a large portion into a glutinous fluid which, when spun out into a fine thread, hardens and forms our silk. Man may yet learn how to ex-

tract silk directly from the leaves, and perhaps even produce the substance which the worm elaborates, and spin it into silk!

Since the telephone has shown that man, through the agency of electricity, can talk with his fellow-man hundreds of miles away, there are men daring enough to think that through the same agency man may yet see things at an equally great distance, so that you may not only talk from Boston to your friend in New York, but may actually see him as if face to face, and they claim that their attempts have been attended with some degree of success. Would you dare to say it is more unlikely that such a result may be achieved than that man should be able to transmit intelligence instantly three thousand miles through the depths of the ocean? Through long ages man remained unconscious of the presence and action of the forces of magnetism and electricity, but we now know that they are constantly present everywhere, and incessantly active. What other forces may still be hidden from the observation of man it is impossible to know.

The present scientific belief is that the atmosphere is an aggregation of infinitely small molecules, which really fill but a small part of the space the air seems to occupy; that through the unoccupied space these molecules are rushing at a high speed, hitting each other and the solid bodies around them and rebounding, and that what we call the pressure of the atmosphere, fifteen pounds to the inch, is really the bombardment of these molecules upon whatever arrests their course. The reason that all solid things are not swept away by this incessant pounding is, that the blows are struck in every direction, and so neutralize each other. But here is an ever-present and ever-active force, and, if man should ever discover a way to make all the particles of a body of air move in one direction, he would have at every place on the surface of the earth an unlimited amount of power placed at his command.

But even if man should accomplish all this, there would still be an infinite distance between anything which he could devise or construct and the organic structures which grow up around him; between the forces which he could wield and those exhibited in the operations of Nature; and each step which he might take, while it would enlarge his knowledge, would at the same time bring him into the presence of new mysteries, and open up to him new problems for solution. Each new invention gives birth to a host of other new ones.

The steam-engine has been the study of inventors for a hundred years, and each year has witnessed improvements upon it, and such improvements are going on more rapidly than ever before.

About forty years have elapsed since Howe gave the sewing-machine to the world, and thousands of inventions for its improvement or adaptation to new uses have been made, and they are going on still. The same is true of reaping-machines, spinning-machines, looms, the manufacture of iron and steel, printing and telegraphy, and of almost everything used by man.

There is no sign that the work of the inventor is near its end, and those who believe, as I do, that he has been the chief agent in the progress of the world, have no reason to doubt that the world will be still more deeply indebted to him as the centuries go by.

There are now in force in this country more than two hundred and fifty thousand patents for inventions, the fruits to a very large extent of the mental labor of those who are called the laboring-men of the country. Aside from the direct value of these inventions in promoting the comfort and increasing the wealth of the country, there is another factor to be considered, having the most vital relation to the industries of the country and its powers of production. This large number of inventions implies a high degree of intelligence and mental activity in the great body of the people. It indicates trained habits of observation and trained powers of applying the knowledge which has been acquired. It shows an ability to turn to account the forces of Nature and train them to the service of man, such as has been possessed by the laborers of no other country. It suggests as pertinent and most important, the inquiry whether any other country is so well equipped for competition in production as our own; whether in any other country the laboring-man is as efficient and his labor therefore as cheap as in our own; whether he does not exhibit the seeming paradox of receiving more for his labor than in any other country, and at the same time doing more for what he receives—giving more for what he receives, and receiving more for what he gives.

COLORADO AS A WINTER SANITARIUM.

By SAMUEL A. FISK, M. D.

WITHIN the past year the civilized world has been shocked and saddened by the knowledge of the great devastation wrought by the cholera in Spain; and every precaution, in the way of sanitary measures and quarantine regulations, that modern science could suggest, was taken to prevent its spreading into other countries. The public scanned the columns of the daily press, eager for information with regard to the advance of this fearful disease, and read with bated breath as they learned that it numbered its victims by the tens of thousands.

If it was a matter of such deep and universal concern that in Spain 101,000 souls gave up their lives to this fell destroyer, should it not also be a matter of some interest to our own people that, within the borders of these United States, over 91,500 persons die each year of pulmonary consumption?*—that twelve out of every hundred deaths are caused by a disease which, though slow in its progress, is as sure in its results as cholera itself?

* Census, 1880.

Should it ever transpire that some means of prevention should be found, by means of which people would be rendered proof against the disease, or at least could be cured when once it had set its seal upon them, would it not be one of the greatest boons vouchsafed to man since the introduction of vaccination?

Inventive persons have from time to time thought that they had secured a sure cure, if not an unfailing prophylactic; and, at the present time, since the discoveries of Koch, all sorts of parasiticides are being used to kill the germ of the disease. The unfortunate *bacillus* is now being hunted down with pneumatic chambers, deep inhalations, and local applications introduced by means of the hypodermic syringe, with results that are, to say the least, uncertain.

But, after all the years of research devoted to the subject, and out of all the methods of prevention and cure that have been suggested, the one that has given the best results, and is now being universally adopted, is change of climate.

Says Professor Frankland, in an article on the "Yellowstone Park as a Winter Resort," which was published in a recent number of "The Popular Science Monthly," * "The great importance of a winter sanitarium for patients suffering from or threatened with consumption and other allied diseases has long been recognized and acted upon in Europe."

Such patients have been hurried off to Mentone and the Riviera, or sent across the Mediterranean into Northern Africa, or they have been told to take a trip up the Nile, and, more recently, they have been congregated at Davos in the Engadine.

If it be true that, on the other side of the waters, they have recognized the importance of a change of climate for the cure of consumption, it is also true that the public and medical profession alike, in our own country, are also awakening to a due sense of its efficacy.

We have our Florida, South Carolina, and Cumberland Mountains, the Adirondacks, Southern California, Minnesota, and Colorado, and New Mexico, where patients are sent indiscriminately, each one of which places has its coterie of especial admirers, and over the respective merits of which a great deal of verbal warfare has been waged.

It is not the intention of the writer to enter upon any arguments with so-called climatologists as to what are the specific elements of a climate adapted to consumptives, nor to give a detailed comparison of the several resorts. Each place can undoubtedly give its instances of remarkable cures, as can also Cape Cod and certain portions of New Jersey; and some rare and isolated cases could also be cited where complete recovery has resulted even in the large cities; but the point is, to determine just where and under what conditions we may invariably look for the best results.

To be able to speak *ex cathedra* on such a matter would require an

* July, 1885.

experience such as falls to the lot of but few, and a long and careful investigation of statistics which have not as yet been compiled.

It is therefore the intention of the present article to give testimony only in regard to the climate of Colorado; to point out to those seeking such information what they may reasonably expect to find here; and to proclaim to that large invalid class in the East and South, to which we ourselves at one time belonged, the restoration to health which we, with thousands upon thousands of others, have found in this glorious climate.

COMPARISON OF CLIMATIC CONDITIONS WITH THOSE AT DAVOS.—Professor Frankland, in the article quoted, sums up the climatic conditions prevailing at Davos, which he establishes as a criterion, as follows, viz.: "1. Great elevation above sea-level (5,400 feet). 2. A continuous and, during winter, permanent covering of snow. 3. A minimum of watery vapor in the air. 4. A clear sun. 5. A clean atmosphere, free from zymotic germs, dust, and fog. 6. A sheltered position, favorable for receiving both the direct and reflected solar rays."

A comparison will show that, in all but one of these conditions, Colorado can make a favorable showing with Davos, and that, taking everything into consideration, she can come nearer to fulfilling the requirements than any other portion of the United States.

As regards this single condition, that of having a perpetual covering of snow, whatever may be its effects upon the Davos climate, we of Colorado have been wont to consider it a great point in our favor that, throughout the winter, we are almost entirely free from snow, and that our sandy and porous soil drinks it up rapidly when it comes. We have regarded this as an advantage, because our sun-temperatures are warm enough without the additional heat of the "reflected rays" that come from snow; because its presence would interfere so materially with the out-of-door life that our invalids lead; and because experience has shown that, where there is the continuous covering of snow as occurs in the Northwest, there comes the thaw, which is usually synchronous with the thaw at the coast, and which brings in its train great atmospheric moisture and chill, and that, too, at a time when patients are seeking to avoid similar conditions at their homes.

In order that we may prove our assertion with regard to our having so little snow, we introduce a table showing the exact amount in inches of rain and melted snow that fell at Denver during the winter of 1884–'85:

TABLE OF PRECIPITATION.

1884-1885.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April.
Amount in inches of rainfall and snow-fall.....	0·13	0·21	0·19	0·76	0·41	0·75	0·97	4·94

To return now to a consideration of the conditions prevailing at Davos, which may, in the main, be taken as those which are most

highly esteemed by the advocates of elevated and cool resorts, we find in Colorado that, so far as elevation is concerned, the range in the towns is from that of Denver, at 5,280 feet, to that of Leadville, which is somewhat over 10,000 feet above sea-level. Intermediate are Colorado Springs, 6,000 feet; Manitou Springs, between 6,000 and 7,000 feet; Cañon City, about the same; Salida, 7,000 feet; Poncha Springs, Idaho Springs, Boulder, and Longmont, about 7,500 feet; Gunnison, Georgetown, and Alamosa, in the neighborhood of 8,000 feet, and so on. So that all the arguments derived from elevation above sea-level are applicable to Colorado as well as to Davos.

If at Davos it is found that there is diminished atmospheric pressure; that, as a consequence, there is a slower abstraction of heat from the body, so that low temperatures do not feel so cold as they would in a lower and denser region; that there is greater heating power in the direct rays of the sun, and that there is a freedom from germ-life (a supposition based on the experiments of Pasteur and Tyndall), all due to simple elevation, the same has been found to be true in Colorado.

As regards the humidity of the air, on which condition writers on climate lay so much stress, and among them the author to whom we have already referred, the data are full and satisfactory.

Colorado is situated in the zone of greatest atmospheric dryness, both relative and absolute, of any inhabited portion of the United States.

A compilation of the statistics of the Signal-Service Bureau, United States Army, shows that the mean relative humidity of Denver for four years was only 45·8. That is, taking the saturation-point, or the point at which the atmosphere is holding all the moisture that it can, as 100, then the air at Denver is only 45·8 per cent of saturation, and it is capable of holding 54·2 per cent more moisture than it does. The same table shows that the air of New York is 70·2 per cent of saturation; that of Jacksonville, Florida, 69 per cent, and that of Los Angeles 65·8 per cent.

It must be understood, in this connection, that the saturation-point is not at all a fixed one, nor is it a constant quantity at any given place, as it varies both with the barometric pressure and with the temperature; so that, as a consequence of this, many writers prefer to speak of the absolute rather than of the relative humidity, in making comparisons of the atmospheric dryness of places.

Several years ago we had occasion to point out, in this connection, that, while a mean for four years showed that the Denver air contained only 1·81 grain of vapor (by weight) to the cubic foot, the air of Jacksonville contains 5·38 grains, and that of Los Angeles 3·77 grains, to the foot; or, as we then remarked, an "amount which, as between Denver and Jacksonville, is as 1 to 3, and, as between Denver and Los Angeles, is as 1 to 2." *

* "Climate in the Cure of Consumption" ("Science," September 28 and October 5, 1883).

Since the above was written, the subject has been very graphically presented by means of colored maps, published in the "Report of the Chief Signal-Officer" for 1884, which maps were compiled at the suggestion and earnest solicitation of the Colorado State Medical Society.*

They show plainly that, in the spring and autumn of 1882, the portion of the United States which contained the fewest grains of vapor to the cubic foot of air (viz., 1·5 grain) was the portion of the Rocky Mountain range reaching from near the northern boundary of Wyoming to about the center of New Mexico and Arizona; and that, while during the winter months the Northwest, owing to the extreme cold, contained only from 0·5 to 1·0 grain of vapor, that section which we are considering contained the same amount throughout its northern half, while its southern half ranged from 1 to 1·5 grain. During the same winter months the vapor along the California coast is marked as having been 2·5 grains to the foot, and in Florida it was 4 grains in the north and 7 grains at Key West.

We wish to emphasize this matter of extreme atmospheric dryness, as it not only plays a most important part in a consideration of the climatic cure of consumption, but it is also a prime factor in making, what to an Eastern mind may appear as low temperatures, not only bearable but even comfortable.

Says Professor Frankland, "The absence of suspended watery particles in the air has, no doubt, very considerable influence in preventing the chilling of the skin"; and this, together with diminished atmospheric pressure—which, the same writer says, makes the air, if still, feel warmer at an elevated station than in lower and denser regions of the atmosphere, "in consequence of the slower abstraction of heat from the body"—these conditions, we say, are the reasons why low temperatures with us do not feel so cold—and, so far as being out of doors is concerned, really are not so cold—as the corresponding temperatures at sea-level.

The next favorable atmospheric condition mentioned as existing at Davos is the fact that there is a "clear sun," by which, we presume, is meant an absence of clouds and a large amount of sunshine.

In this connection we have previously called attention to the fact that there are in this climate, on the average, three hundred and twenty sunny days per annum, when the invalid can be out of doors. In other words, our cloudy days, as interpreted by the Signal Service —i. e., days when the heavens are from seven tenths to ten tenths obscured by clouds at 7 A. M., 3 and 11 P. M., Washington time—our cloudy days average only forty-six, while in New York they average one hundred and nine, at Jacksonville eighty-seven, and at St. Paul one hundred and four per annum.

This fact also has been graphically portrayed by another series of

* As a member of the committee from that society, intrusted with the matter, we take pleasure in acknowledging the courteous attention our request received.

maps, furnished by the Signal-Service Bureau to the Colorado State Medical Society, at the time that they gave the series illustrating absolute humidity. This is a series of four maps, representing in color and by seasons the amount of cloudiness existing throughout the United States. They show that Denver was in the region of greatest sunshine for the autumn and winter of the year 1882, while in the spring months of the same year the greatest amount of sunshine was found in lower Arizona, and the country immediately surrounding it.

This element of sunshine, as affecting the ability of an invalid to lead an out-of-door life, can not be too highly estimated. That most eminent authority, Dr. Austin Flint, in speaking of the good to be derived in cases of consumption from a life out of doors, writes, "It is probable that to this source much of the benefit derived from change of climate is to be referred." * Certainly the experience of every practitioner of medicine, who has had much to do with treating the disease, will bear out the assertion of the distinguished writer, and it may safely be said that, *cæteris paribus*, a patient's recovery will depend very largely upon his ability to lead an out-of-door life.

So well recognized a principle is this, that our medical journals nowadays are teeming with instructions to patients, who, for lack of means or other cause, are unable to take a change of climate, as to how they can best lead out-of-door lives at home, going so far, in some instances, as to advise them to wrap up warmly and sit in an open window, where they can get sunshine and fresh air without a draught.

Finally, stress is laid on the fact that Davos is in a sheltered valley. Without going into details, for it is not necessary to enumerate such places, it may be stated that there are towns situated at various elevations among our mountains and foot-hills, so sheltered as to be very free from winds, and adapted to receiving both the direct and reflected rays of the sun.

If it be admitted, then, that the Davos climate is the ideal one for a consumptive—and the writer of the article referred to, together with many European authorities, seems to regard it as such—we think that we have clearly proved that, as regards the elements of great elevation above sea-level, a minimum of watery vapor in the air, a clear sun, a clean atmosphere free from zymotic germs and fog, and a sheltered position, Colorado fills the bill as completely as does Davos itself.

CONSIDERATION OF THE CLIMATIC CONDITIONS OF AN INVALID'S DAY.—It may not be out of place now to refer to the charges that some writers have preferred against this climate. One throws it up against us that we have high winds, which cause our visitors to complain.† Another says, "The enormous monthly and also diurnal range of temperature must severely try any man." ‡ While a third,

* Pepper's "System of Medicine," vol. iii, p. 432.

† "Boston Medical and Surgical Journal," June 12, 1884.

‡ "New York Herald" editorial, December 29, 1883.

who has published one of the fairest and most intelligent articles ever written on our climate, criticises the statistics so far published as inadequate, inasmuch as two of the three observations, on which they are based, occur at 5 A. M. and 9 P. M.—hours that in no way concern the invalid.*

With a view to answering these objections and those of other writers, we append the following tables, compiled from the official data on record at the Signal-station in Denver. We have taken the months that may fairly be considered as the invalid's winter, and the hours that constitute the invalid's day, and we have selected the winter closest at hand (at the time of writing), so that the reader may from his recollection compare the data we present with the conditions existing at the place where he was at that time.

We furthermore hope that these figures may be of service to those who may be meditating coming to Colorado, as showing them what climatic conditions they may reasonably expect to find :

1884-'85.		Mean temperature.	Relative humidity.	Wind prevailing.	Velocity per hour.	Days without sunshine.	Foggy days.
9·08 A. M., local time...	September..	67·4	59·6	S.	5·3	2	0
	October....	56·2	48·2	S.	1·5	7	0
	November..	41·6	45·4	S.	5·7	3	0
	December...	25·6	61·6	N. & S.	6·3	11	0
	January....	27·0	56·2	S.	7·	5	0
	February ...	31·9	65·0	N.	8·5	9	0
	March.....	41·3	51·5	S.	6·	4	0
	April	47·7	55·5	N.	5·3	12	0
			52·8		5·7	6·6	
1·08 P. M., local time...	September..	75·4	25·5	E.	7·5	0	0
	October....	61·1	32·2	N.	6·1	2	0
	November..	53·3	31·6	S.	6·7	4	0
	December...	32·5	54 1	N.	6·7	9	0
	January....	35·8	48·6	N. & W.	8·1	5	0
	February...	38 0	57·4	N. E.	10·4	9	0
	March.....	48·2	39·5	N.	9·2	5	0
	April	53·9	43·1	N.	9·3	5	0
			41·5		8·0	4·8	
5·08 P. M., local time...	September..	74·6	28·0	N. E.	8·6	3	0
	October....	64·1	37·7	N. E.	7·4	5	0
	November..	49·9	37·3	N.	6·4	6	0
	December...	26·8	63·4	N.	6·8	9	0
	January....	33·3	53·1	W.	8·7	3	0
	February...	37·8	55·5	W.	11·2	5	0
	March.....	47·7	40·9	N. E.	10·7	7	0
	April	54·3	47·8	W.	9·1	6	0
			45·5		8·6	5·5	

FOGS.—A study of these tables shows that such a thing as a fog is of very rare occurrence, there not being a single one recorded at any of the three observations.

* Dr. Edward T. Ely, "New York Medical Journal," July, 1884.

HUMIDITY.—We next observe that, of the three observations, the air carries the most moisture at the 9 A. M. one, an amount which is, on the average, only slightly in excess of one half of saturation; that the midday air is quite dry, giving a mean for the eight months of 41·5 of saturation; and that at 5 P. M. the average of humidity is 45·5 per cent of saturation—all of which simply strengthens what we have previously said in regard to the dryness of the Colorado climate.

TEMPERATURE.—As regards the temperature we learn that, as we should expect, the coldest registrations occur in the months of December, January, and February; and that even in these months an invalid can be out of doors, so far as this factor is concerned, from 9 A. M. to 5 P. M.

In considering this question several things must be borne in mind. In the first place, these registrations are those of thermometers placed in a "shelter-box," and consequently in the shade, with a northern exposure, and ten feet above the roof of a six-story building, and so they are not influenced by the direct solar rays, which are very powerful. It must further be borne in mind that these registrations do not "feel" so cold as similar ones would in a dense and damp air, like that of either New York or Boston, owing to the fact that we have mentioned, viz., that a thin, dry air does not rapidly rob the body of its heat, and so the skin does not become chilled so rapidly as at sea-level with the same temperature.

As a matter of fact, the writer remembers that he went around at midday the greater part of the winter without an overcoat. He recalls sitting with open windows in the very heart of January, and was accustomed to seeing people sitting out of doors basking in the sun.

And right here he is willing to acknowledge that there is a grain of truth in the criticisms broached with reference to our extremes of temperature, both diurnal and monthly. They do occur, but then only rarely (that is, such extremes as have been quoted against us), and, when they do come, they are due to high temperatures in the daytime and very low ones at night—conditions which can occur only in thin, dry airs like our own.

The night temperatures are uniformly cold; but they do not affect the invalid, because he should at that time be housed, where he can regulate the temperature to suit himself, and our tables show conclusively that the hours of sunshine are warm and comfortable.

We regret exceedingly that we are not able to give the "sun-temperatures," as they would convey a more correct impression of the warmth of our midday, as every person knows who has tried the difference between the shady and sunny side of the street in our city. But we know of no data on that point, and our Signal-station is not as yet supplied with a sun-thermometer.

WINDS.—As regards the winds, these tables prove that in Denver at 9 A. M. the prevailing direction is from the south, and that at 5

P. M. it is either from the north or west. They do not, however, show the well-recognized daily change from the south at night to the north during the day. Furthermore, the observations have reference only to Denver, and can not be taken as a guide for other places, where the peculiar topography must exert a controlling influence.

Moreover, the tables teach most conclusively that the mean hourly motion, at any one of the three observations, is mild, and probably rather less than would prevail in New York city at the same hour of the day. Certain it is that in 1880 the corresponding mean velocities for the twenty-four hours were as follows, viz. :

1880.	Spring.	Summer.	Autumn.	Winter.
Denver.....	156*	143	115	127
New York.....	247	177	192	222

While our tables show that the average hourly movement of the wind is moderate, it is true, as some object, that we do have occasional squalls, when the dust is picked up by the wind and when it is disagreeable to be out of doors. We speak of the dust, for it must be remembered that snow does not lie on our ground, even in midwinter. But such squalls are no more frequent than one will meet with in the autumn months in Boston. In violence they bear no comparison, as we can testify from personal experience, to many a tornado that has occurred of late years in the valley of the Connecticut River, and should by no means be confounded with the blizzards of the Northwest nor the cyclones of Kansas.

SUNSHINE.—We next learn, from a consideration of the tables, that while there occurred days in the winter under observation when the sun was not shining at 9 A. M. or at 1 P. M. or at 5 P. M., as the case might be, there were only eleven days in the whole eight months when the heavens were completely and wholly obscured at all three observations. In other words, there were only eleven days in the winter of 1884–'85 when the sun did not shine upon Denver between the hours of 9 A. M. and 5 P. M., and they occurred as follows, viz. :

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	Total.
Completely cloudy days, from 9 A. M. to 5 P. M.	0	1	1	1	1	1	3	3	11

We may fairly conclude from these figures that there were only eleven days, out of the two hundred and forty-two, when the invalid was detained in doors all day long for want of sunshine.

* The figures in this table should read so many miles *per diem*. In the former tables the velocities are given in miles *per horam*.

While in New York recently, we tried to obtain data of observations at 9 A. M., 1 and 5 P. M., local time, as a means of comparison, but they were not to be had at the Signal-station.

Surely this is a surprising showing, and one which, in itself, sufficiently indicates the character of our climate.

RÉSUMÉ.—To sum up, then, the information we have gathered with reference to the nature of the Colorado climate, between the hours of 9 A. M. and 5 P. M., the invalid's day, and during the eight months from September to April inclusive, the invalid's winter: we have learned that the days are very few, probably not more than two in a month, when an invalid can not be out of doors, gaining health and strength; that the air is warm enough to admit of his being out the greater part of the time from 9 A. M. to 5 P. M., and by this we mean with comfort (certainly, even the most sensitive invalid can get several hours out of doors at midday); that, while there are occasional high winds, they are not more frequent than occur elsewhere, and the average daily motion is mild—not more than is enjoyable and conducive to purity; that the air is an exceedingly dry and bracing one, and that fogs are of very rare occurrence.

Are there not in these conditions the most desirable elements of climate for the consumptive? Here are to be found the greatest amount of sunshine to be had anywhere in the United States; a dry air, a rarefied and pure air; absence of fog; a dry soil free from snow and moisture; a temperature that admits of out-of-door life with comfort; and a daily movement of the air that is mild and gentle—all of which conditions combine to tempt the invalid to a life in the open air.

Says Professor Frankland of Davos, "In the brilliant sunshine one feels comfortably warm sitting in front of the hotel in a light morning coat." What would he say of a climate where the sun shines so brightly and the air is so mild that picnics are admissible, and out-of-door sports, such as riding, driving, tennis, quoits, etc., can be indulged in the greater part of the winter?

Before concluding the article, we wish to say a few words in regard to what seems to us to be the weak point of Professor Frankland's advocacy of the Yellowstone Park as a winter sanitarium; an objection which, we think, would be sufficient to condemn any place as a resort for consumptives, no matter how advantageous its climate. We have reference to its distance from the settled portions of our country, and the lack of accommodations in the park itself. These features, which Professor Frankland recognizes and mentions, must, for the present at least, put the Yellowstone Park entirely out of consideration as a winter resort for the consumptive; for he will not be willing to subject himself to a journey of five or six days by rail, a stage-ride of thirty hours, and the utter isolation of such a place, to say nothing of its lack of accommodations, simply that he may winter in an elevated region, possessing "a continuous and, during winter, permanent covering of snow"—a covering of snow which, by-the-by, is deep enough, so I am credibly informed, to drive the big game from the park during the winter months.

Here in Colorado, however, the invalid can find comfortable and adequate accommodations at reasonable rates. He can enjoy the comforts of settled communities at the same time that he is putting himself under superb climatic conditions. He will have access to a market which can amply supply his demands, even should he desire such delicacies as a live lobster or oysters in the shell. He will be in direct telegraphic and postal communication with his home, and, should occasion demand, can walk the streets of Boston within three days of leaving Denver.

These are considerations of no little weight to the invalid, for he is a human being, sensitive like other human beings—in fact, rather more dependent on the comforts of life than other men—and he protests, and rightly too, that it is cruel to impose conditions on him which would depress and render sick even a strong and able-bodied man.

The idea which has been so prevalent, and which even now is not entirely eradicated, that to regain health it is necessary to "rough it," and the greater the privations one endures, the more he roughs it, the sooner he will get well, is an erroneous and most cruel one.

It is not necessary to pander to the consumptive so as to make him a hypochondriac; and yet, on the other hand, we protest against the rough usage so often entailed upon him, which would seem to justify the idea that the only way of curing the disease is by fairly knocking it out of a man.

We consider the proper regulation of an invalid's life as regards exercise, diet, hygienic conditions, accommodations for living, etc., as of great importance—equal, it may be, to considerations of climate.

We have already * given to the public our opinion of what they can expect to find, on such scores, in Colorado, and need not now weary the reader with a repetition.

We at that time took occasion to mention the kind of cases that, in our opinion, should *not* come to Colorado, and we will now briefly repeat the advice. It is an excellent place for persons in whom a recovery can reasonably be expected, but it is not a place where consumptives should be sent as a last resort.

In conclusion, we can only say that, if the figures and arguments we have adduced are not convincing, or if the reader is skeptical about the ranges of temperature and unbelieving in regard to the heating effects of the direct solar rays, or the further fact that low temperatures do not feel so cold in our light and dry air as at sea-level, or if he can not reconcile the facts presented with any theory he may hold, we can only say to such a one, "Come and see."

The theories in regard to the beneficial elements of elevated regions may be entirely erroneous. Men's theories are constantly changing, and it may or may not be true that elevation, dryness, and sunshine

* "Colorado for Invalids," "Popular Science Monthly," July, 1884.

are the sole desiderata in selecting a suitable climate; or, on the other hand, that equability of temperature should alone be considered.

Writers may still object that we have high winds and sand-storms, which annoy the visitor; or that "the enormous monthly and also diurnal range of temperature must severely try any man"; or raise one objection after another on merely theoretical grounds: and yet the fact remains—a fact that rises superior to all argument and cavil, and which is in itself the most conclusive argument that can be advanced—that a large percentage of our population is made up of the so-called invalid class, who have obtained a restoration of health here; that thousands upon thousands of lives have been saved to the world, not to drag out an invalid's existence, but rather to take a manly part in the struggles of life, simply by coming to Colorado; and that to-day there are living within its borders persons, to be numbered by the tens of thousands, who would undoubtedly be glad to attest their gratitude to the climate by saying of it, as the writer thinks he can truthfully say, "It saved my life."

DURABILITY OF RESINOUS WOODS.

By HEINRICH MAYR, Ph. D..

THERE can be no doubt that the resin in the wood derived from the different varieties of conifers, or pine-trees, is one of the most important factors which determine its quality, especially its durability and resistance against the influence of weather and the different forms of rot, all of which are now proved to be due to specific fungi. Just at present, timber from American conifers is highly valued in Europe, because of its richness in resin, although the amount of resin in wood is not the sole measure of its quality.

Until now an exact valuation of the importance of pitch in wood was impossible, because the accurate knowledge of the origin and the distribution of the resin, as well as of the arrangement of the organs producing it, was wanting.

At the experimental botanical station at Munich, I have made numerous experiments during a space of many years, and, as the results seem to contain many new points, I thought them worth presenting to the readers of the "Monthly." In face of the confusion prevailing in the nomenclature, it is necessary to state that the botanical names used are those of Carrière in his "Traité des Conifères," who separates *Abies* and *Picea* as distinct genera. The distribution of the resiniferous ducts is so characteristic within each of these genera as to serve as typical marks for them.

The species of *Abies* commonly called firs are characterized by the absence of resiniferous ducts within their woods; it is only in rare

cases, as in *Abies firma*, or Japan fir, that we meet with them. Sometimes we find a cluster of parallel cells, often quite far apart from each other, filled with resin; these colonies of parallel cells are not to be considered as ducts, but as malformations due to the influence of different causes like cold and pressure; they are found also in other species of conifers exposed to the same causes, and occasionally attain the size of a man's hand.

The resin is produced only by the parallel cells of the medullary rays in the species *Abies*. Already in the first year's growth the cells are found to contain small drops of resin. The size of these drops increases with the age of the cells, the amount of amylum or starch in them decreasing in proportion.

Resin is composed of substances volatile at 100° C., and others which can not be distilled without decomposition; the latter form the solid residue, when resin or pitch is distilled with water. When the outer or sap wood (*alburnum*) becomes dry or heart wood (*duramen*), in which form it is that which is known commercially as wood, the cells are found to contain nothing but air with the resin coating the inside of the cell-walls; fresh pitch, as it oozes from the bark of the European *Abies pectinata*, contains 63 per cent of solid residue, and this is also the percentage of solid substances in the pitch of the sap-wood of the genus *Abies*, but pitch from the heart, or from the dry, inner wood of the tree contains 70 per cent of solid substances.

During the life of a fir-tree the cells contain 50 per cent water, which, when the wood dries, disappears, and the pitch, which at first could not enter into the cell-walls, now permeates them, taking the place of the water.

The wood of *Abies pectinata*, which in Europe covers thousands of acres in dense, well-cultivated masses, contains the least resin of any fir cultivated, namely, only $\frac{12}{100}$ per cent of the perfectly dry sap-wood, while the innermost layers of heart-wood contain $1\frac{1}{3}$ per cent of pitch; it is therefore of inferior quality as far as richness in resin is concerned; only the very great heights and diameters which trees of this species rapidly attain make them valuable for cultivation.

The genus *Picea* (spruce) has the sap-wood of the same color as the heart-wood; it contains numerous ducts filled with resinous substances. These ducts run in all directions, the horizontal ones being branched off from those running perpendicularly, and communicating with others lying closer to the bark, running vertically. The inside of the ducts is made up of two kinds of cells, the one having thick walls and the same functions as the parenchymatic cells of medullary rays, the others having thin walls. The latter were formerly considered as mere cells of secretion producing resin; but there are many reasons which force me to consider them as merismatic cells, remaining without function sometimes for several years, until the sap-wood containing them becomes dry or heart wood, when they begin their

activity. They now increase in size, expanding like vesicles, and totally obstructing the duct, so as to prevent the resin from entering the heart-wood by way of the horizontal duct or sinking from a higher to a lower part of the tree. In the amount of resin contained in the wood, the genus *Picea* ranks second among conifers; the species *Picea excelsa,* common in Europe, contains 2·16 per cent in the sap-wood and 1·6 per cent in the heart-wood. The amount of pitch increases with the age of the tree.

I have found as a result of my investigation that there exists a very important law which will enable a microscopist to tell at a glance the difference between heart-wood and sap-wood: only the heart-wood is fit for building purposes and will stand the influence of weather; the sap-wood will decay rapidly, but is nevertheless used by unscrupulous builders. An examination of the resiniferous ducts will show the difference at a glance. During the process of transition of the sap-wood into heart-wood, *all these resiniferous ducts become closed* by the expansion of the cells surrounding them, a process which can be discerned unmistakably even in the smallest piece of any wood from a conifer; a similar process takes place in the growth of the bark.

Professor Hartig, of Munich, a famous botanist, proved by careful experiments the following law: *The quality of the wood of all trees increases so long as the yearly growth shows a progressive course year after year.* It has been thought until now that the quality of the wood of conifers is the better the closer the annual rings lie; this is but partly true. The older the tree the closer the annual rings, but the quality of the wood increases only as long as those rings represent an actual progress of growth; when once the annual amount of wood formed begins to diminish year by year, its quality becomes impaired, notwithstanding the rings become closer and narrower.

The amount of resin in the wood of a tree follows the same law: if we take, therefore, a splinter or a plug from any tree by means of a hollow auger, we can, by a simple calculation, determine whether the tree is still progressing, or already on the decline in growth, quantity of resin, and value.

In the genus *Pinus* the resiniferous canals are of different construction, but agree in general arrangement with those of the genus *Picea;* their size is larger and they are inclosed by only thin-walled, merismatic cells, which in the course of the transformation of the sap-wood into heart-wood enlarge and close the canals.

The heart-wood of the trees of the genus *Pinus* has a light-brown color, sometimes a little reddish, the coloring being due to a product of the oxidation of tannin, which is found in the cells and their walls.

Among the species of this genus several deserve a more elaborate mention:

The Scotch pine (*Pinus silvestris*), when growing on sandy soil, forms only a very small amount of sap-wood, whereas on gravelly and

shallow ground it produces more but of less valuable quality. Two needles in one sheath characterize this species. The heart-wood of this pine contains 5·7 per cent of resin, the sap-wood proportionately less.

The sap-wood of this tree is quickly destroyed when the tree is cut; it assumes a dark-blue color and rots, through the agency of the mycelium of a fungus called *Ceratostoma piliferum*.

This tree is at present the most valuable and most cultivated timber-tree of Northern Germany.

The white pine, or common American pine (*Pinus strobus*), is now also extensively cultivated in Germany, where some forests can be found of trees about a hundred years old. Its wood has the lowest specific gravity of all coniferous wood. In spring, on account of the thinness of its bark, the tree is quickly warmed through, and the wood-cells, formed in the beginning of the spring, are thin-walled; at the close of the period of vegetation in summer, the annual rings are finished by a few thick-walled narrow cells, thus giving only little thickness to the hard part of the annual layer. In amount of resin this pine stands at the head of all conifers, containing 6·9 per cent. The percentage increases up to the age of one hundred years, and with it the quality of the wood. It is of little value when young and exposed to moisture. *Pinus cembra*, a native of the Alps and Siberia, forms only small, dense rings every year during the short summers of these regions; the wood hence becomes heavier, and, although less resinous, more valuable.

A very valuable tree of Europe is the larch (*Larix Europæa*), which is native only in the colder regions of Europe and Asia; its wood consists of narrow annual rings, grown during the short summers of those countries. In the percentage of resin it stands between *Pinus* and *Picea;* its wood is more reddish, like that of the genus *Pinus*, and its resiniferous ducts are constructed like those of *Picea;* it contains 3·9 per cent of resin.

Just now, the different German governments are experimenting with the introduction of American trees which, it is expected, will stand the climate and furnish better wood, or, in proportion, a larger quantity, than the German forest-trees now cultivated. One of those of which much is expected is the *Douglas spruce* (*Pseudotsuga Douglasii*). Mr. J. Booth, of Hamburg, has cultivated this tree for a long time, and has already some very fine specimens in his park. I was enabled through his kindness to examine its wood carefully; the specific weight is very much above that of European conifers of the *Pinus* genus, but not as high as that of the larch; its quality increases in proportion to the width of its layers—a fact which, until a short time ago, was considered directly contrary to what is the case with wood from European pines.

Professor Sargeant, of Cambridge, has made the contribution to

the United States census which embraces the researches and experiments with American trees. This report, one of the most valuable of its kind from the great amount of statistical information contained in it, has been made with specially painstaking care; the distribution of American trees, the determination of their specific weights, their chemical composition in regard to mineral constituents (ashes), their commercial value, their strength, elasticity, and resistance, form the contents of a large volume. Compared with the figures obtained by Professor Sargeant, the wood of European forest-trees appears to be somewhat inferior in quality to that of American trees. The Bavarian Government, which on its 24,000 square miles of territory has over 7,000 square miles of forests, of which over 3,000 square miles are in solid masses, under a model administration of the Government, yielding about four per cent net profit, is wide awake for improvements, and has sent me to this country to investigate as fully as possible the facts about the growth of American forest-trees, their relation to the climate, and their yield of timber in quantity and quality. With their usual liberality and hospitality, the American authorities and learned men have lent a helping hand, truly worthy the spirit of a great nation not influenced by petty considerations of a possible rivalry.

INFANCY IN THE CITY.

By GRACE PECKHAM, M. D.

ACCORDING to Quetelet, "there die during the first month after birth four times as many children as during the second month, and almost as many as during the two years that follow the first year, although even then the mortality is high. The tables of mortality prove, in fact, that one tenth of children born die before the first month has been completed."

The census has shown that the mortality of infants in cities is twice as great as that in rural districts. In New York, in 1883, 28,972 children were born, and 8,668 died in their first year, thirty-three and one fourth per cent; 2,660 children died in their second year, 1,221 in their third year, 787 in their fourth year, and 525 in their fifth year, a total of 13,865 deaths of infants, almost half of the total number of deaths occurring during that year, which was 31,011.

The question arises, What is it in cities that is so hostile to infant life?

The subject is a complex one, and in its analysis we must consider the varying conditions surrounding the different classes. Distinctions of rank are as definitely marked among infants as among adults. There is none of the democracy which obtains in the country. We

have the infant of aristocracy, the infant of the middle classes, the infant of the poor, the infant dependent upon charity. Each of these inherits an environment peculiar to itself; its house, its nursery and sleeping-apartment, its nurses and attendants, who solve the problems of its food and raiment. Take the matter of inheritance, not of money or lands, but of constitution. The extreme classes found in the city and not in the country, the very wealthy and the very poor, are likely to bestow on their offspring a latent tendency to disease. The ultra-fashionable mother, the self-indulgent father, hand down to their children overwrought nervous systems and weak physical powers, which result in early death, or more often a life of protracted feebleness. In the lowest classes the untoward effects upon the children of poverty, intemperance, and moral obliquity are incalculable.

The city infants belonging to the middle classes often suffer because of the struggle of their parents to maintain a foothold in society, and to mount the steps in social life which will bring them distinction. It would be a long discussion to enter into all the questions of heredity which influence the fate of a child. They are vital questions, however, which require the utmost delicacy in handling, but which are of transcending importance to the individual and to the race. Very little of the common sense which prevails in preserving and rearing choice stock exists in relation to the human animal. If by chance the infant is well-born—that is, has the germ of a constitution which will unfold untainted by scrofula or epilepsy, or any other foul disease which will rob it of a healthy mental and physical development as life unrolls before it—such inheritance is unequaled. Dr. Ireland has shown the effects of heredity as seen in tracing through three hundred and fifty years the health history of the house of Spain. The children, though born to a kingdom and a crown, were cursed with an hereditary nervous taint which sometimes passed over a generation only to appear again in various forms and intensities as epilepsy, hypochondria, melancholia, mania, and imbecility, till at length it extinguished the direct royal line.

With a multitude of hereditary tendencies germinating within it, the city infant opens its eyes upon surroundings which are to influence it scarcely less. About city homes lurk unseen perils to babies. There has been much written and said about the plumbing of city houses and the evils which have sprung from it, so that now, when children are afflicted with diphtheria, immediately comes the question, Are there escaping sewer-gases in the house which they occupy? Dr. J. Lewis Smith remarks that diphtheria appeared in New York in 1858 after an absence of more than fifty years, the most severe cases occurring in the upper part of the city along old water-courses, where in consequence of street-grading, water was stagnant and impregnated with decaying animal and vegetable matter. The infants are more liable to succumb than those older, as the poison acts more quickly on

their susceptible systems, and, as they are shut up in the house, they are much more exposed to it. Especially is this true in the tenement-house, where the surroundings of the city infant are at their worst.

Lack of pure air, air untainted with human emanations and sewer-gas, is one of the great causes of infant mortality in cities. It deteriorates the health of the naturally robust; it robs the delicate of their chances for life; it sows the seeds of contagious diseases; it hastens the fatal termination of those who are sick.

Many mothers, anxious for their children, with mistaken zeal protect them from the fresh air. They are especially afraid of night air, and shut their babies up in rooms which would make a well person giddy and sick to enter in the morning. In the country, houses are built less substantially and in exposed situations, and the fresh, searching air will find its way in, in spite of unhygienic resistance.

The little ones are too often brought up on the hot-house plan. Mothers, however, are awakening to the fact that babies must have their airings, and among the better classes the nurse takes the baby out every day when the weather will permit. One must admire the beautiful infants in perambulators, the chubby little run-abouts that are to be seen in the city parks and squares. Their handsome faces, finely formed figures, and rosy cheeks, go to show that children in the city, when properly cared for, can become the embodiment of health. In the country the children are usually looked after by their mothers, who have an average amount of intelligence.

Babies who are constantly held and watched and tended do not thrive. They grow fretful, uneasy, and pale, no one knows why. The aristocratic baby is at a disadvantage in this respect, unless money —as it may sometimes—procures an intelligent, faithful nurse, a foster-mother.

To intrust an infant to some baby-tenders is almost as much an act of abandonment as that of the heathen mother, who throws her babe into the jaws of the crocodile of the sacred river. The children who have grown up through a wretched childhood to a crippled and deformed maturity caused by the carelessness of nurses, who have let them fall or otherwise injure themselves, are not a few. Nevertheless it must be said that when the number of nurse-girls who take care of little ones alien to them is considered, the patient devotion and painstaking fidelity they show to fretful children spoiled by indulgent parents are marvelous.

If the rich children are spoiled by over-attention, this can not be said of the children of the poor. The little waif born in the tenement-house, if it has no brothers or sisters, is often locked up by its mother and left an hour or two by itself while she goes out to work, to gossip, or to shop. If she goes out by the day, an obliging neighbor (and the poor are wonderfully helpful to each other) will let the child come into her apartment, where it can sit on the floor or the dirty bed

and play, or cry, or sleep, as it will. The neighbor's nerves are not weak as far as children's crying is concerned. The day-nurseries which benevolence has established for the care of these little ones are truly a blessing to poor mothers, who earn their living by washing and scrubbing. The babies are well fed, amused, and generally well cared for, far better than in their own homes; the mothers pay from five to ten cents a day out of their wages. But more often the poor baby has brothers and sisters, and they take care of it almost entirely.

Many city infants perish from bad feeding. More especially is this true of the tenement-children. The youngest member of the family is placed at the common table at an incredibly tender age. Often in the dispensary in response to the question, "With what are you feeding your baby?" comes the reply, "It eats what we all do." With these people, even if they are not extremely poor, milk or anything else purchased especially for the baby, is an item of extra expense, and therefore it is considered easier and cheaper to feed it with the rest of the family. The sins of feeding among the poor people are monstrous. Coffee, tea, brandy-and-water, as well as beer, had been fed to babies from their nursing-bottle! With such a *régime* of feeding for the poor and middle classes, it is no wonder that two and a half times as many infants perish of diarrhœal disorders as of any other disease.

City infants of all classes are at a disadvantage in regard to their food. Unfortunately, city mothers who nurse their own children are fewer than those in the country. The search for a wet-nurse is one of the most disheartening. The supply is in no way proportioned to the demand. A woman of the poorer classes who has any home at all must stay in it and look after it for her husband, even if she were willing to give up her child for the sake of the money. The woman who applies for the position as wet-nurse has either been deserted by her husband or has had none. She must depend upon her own exertions for the support of herself and her child. If she finds a place as wet-nurse she earns from twenty to thirty dollars per month and a good home, for it is only the well-to-do who can afford to hire her. She usually rules the household with a rod of iron. Since, as a general thing, she comes to take care of a puny child who can not live without mother's milk, and recognizes that the family are dependent upon her, she is exacting and aggravating, oftentimes almost beyond endurance. It is only because the thralldom will not last forever that it is tolerated. The wet-nurses obtain their positions through agencies which exist in the large cities and through advertisements. The necessity for a thorough investigation of the health and status of the applicant for such a position by the family physician is imperative, and in recommending one he takes upon himself a grave responsibility. The wet-nurse will generally try to deceive as to the age of her baby, that she may make her milk appear desirable. The best evidence is the

mother's own infant, which should be seen if possible. And it must be remembered that even here another imposition may be practiced—a neighbor's baby can be borrowed for the occasion. The flattering testimonials of fidelity and satisfactory conduct in previous positions are often from employers who have departed for Europe or some other quarter of the globe, and are therefore inaccessible. When success has rewarded the search for a wet-nurse, there is no guarantee that her milk will remain satisfactory for any length of time. If she has the true maternal instinct, she mourns for her own child, and it is not long before, deprived of its proper nourishment, it sickens and, more often than not, dies, and the grief of the mother dries up her milk.

The question of artificial feeding becomes, then, one of paramount importance, since the largest proportion of city infants must subsist in this way. In summer it is indeed a difficult task to raise an infant in the city. New York physicians know very well that a large proportion of artificially fed infants who enter the summer months die before the return of cool weather, unless saved by removal to the country.

One of the most benevolent institutions which has been devised is the Floating Hospital of the St. John's Guild of New York, which daily in summer takes its freight of pallid, almost dying, infants, suffering from faulty nutrition, out into the fresh ocean-breezes for the day.

Cow's milk coming from a long distance is unfitted for infant feeding; but, if it can be obtained fresh, it is the best substitute for mother's milk. It must be diluted the first six weeks one half, the next six weeks one third, and after three months a fourth, and at five or six months it can be given pure. The feeding-bottle should be perfectly sweet and clean. It has been found both in private practice and hospital experimentation that milk which has been prepared with the extract of pancreas can be used more successfully than any other. Infants' foods abound in the market, whose inventors claim all sorts of merits for them. For a while one food will prove advantageous, when, having obtained a reputation and come into extensive use, less care is taken in its preparation, and through the suffering of many infants it is proved unworthy of longer confidence. Goat's milk is good for city infants, because it can be obtained fresh, and the animals can be kept by poor people at little expense.

Many an infant suffers from irregularity of feeding and overfeeding. There is in the popular mind but one interpretation of a baby's crying, "It is hungry," and immediately it is given more food to eat, when already its tiny stomach is distended and irritated. Infants' meals should be regulated by the clock.* This prescription, unaided

* An infant under three weeks should be fed every two hours, or twelve times in the twenty-four, receiving one to one and a half ounce of cow's milk each time, if artificially fed. At three months the child should be fed every three hours, or eight times in the

by anything else, has often restored a nursing baby to equanimity and to health.

Of less vital importance to a child perhaps than its food, yet claiming no little attention, is the clothing. The mothers of to-day have learned by experience how to clothe their children better than their mothers clothed them. It hardly seems possible that at one time the fashion of dresses low in the neck and with short sleeves was well-nigh universal for infants. The babies of the aristocratic and middle classes are, as a general thing, warmly and properly clothed. Careless attendants sometimes dress them too tightly, not allowing room for the expansion of the chest and lungs and interfering with the stomach. The senseless extravagance displayed in embroidered dresses for small children is reprehensible, and too fine dressing which prevents young children from obtaining proper exercise and trammels their freedom of play interferes with their health and development. American mothers are often very blameworthy in this respect.

The effects of disease on city infants are much more wide-spread than upon those in the country, not only of disease caused by improper feeding, to which we have already alluded, but more especially of those of a contagious nature. All sanitarians recognize this, and bewail it as one of the greatest evils of the present tenement system that so many children are crowded together in such houses, which become hot-beds of diphtheria, scarlet fever, and measles.

The terrible stories with reference to baby-farming which used to fill the columns of the newspapers are not so often seen in these days. Owing to the ventilation of the subject, the abuse has been very much lessened. But the question may be asked, Who supply the baby-farmers? A few are those who would abandon their offspring, no matter how, to hide their shame, but for the most part they are poor women who are without a home, and must win a support the best way they can for themselves and their infants. They go out as wet-nurses; return to the factories and shops; or engage in general house-work.

The women who find their way, utterly destitute, to the lying-in institutions of a great city, amount to a considerable number in a year. Any of these coming to New York can go to Charity Hospital by obtaining a permit from the Superintendent of the City Poor. They leave the Maternity from ten days to two weeks after confinement. If they wish they can go with their infants to Randall's Island, or they can leave their children there while they go out to seek employment. At almost all other institutions the women are obliged to pay at least twenty-five dollars for board and care during confinement, or stay with their children three months. They can and often do remain with them a year.

twenty-hour, receiving three ounces of milk at each feeding, which at six months is increased to four. The times of feeding should be fixed, but of course the amount taken will vary more or less with the individual.

The charity infant who has opened its eyes in an institution is peculiar to the city. Its chances for life are less than those of any other class. Most of these babies if bottle-fed will die, as has been demonstrated in some of our nurseries. This is not because the infants are especially unhealthy when they come into the world. It is surprising, when one considers what hardships, physical and mental, the mothers have endured, that the children should be as robust and well-formed as they generally are.

In view of the disastrous effects of artificial feeding, the plan now adopted is to have a woman nurse her own baby and one other. In this way the mortality has been greatly reduced. The public infant is probably best cared for when sent into the country and boarded with farmers, and this is now extensively done by some of the institutions.

ARBOR-DAY.

By N. H. EGLESTON.

AMONG the agencies by which we may hope to remedy the evils threatening us on account of the rapid wasting of our forests, Arbor-day promises to be one of the most important. A little thing to begin with, it is capable of such expansion as to become a wide-spread power for good.

For the settler on the naked, wind-swept prairie, to plant trees was one of the first necessities of life. Certainly, without the presence of trees existence there could not be comfortable, and the tendency of one's surroundings was to forbid any but a low type of civilization or of domestic life. Fertile soil is not all that is needful, nor can man live, as he was designed to live, by bread alone.

But manifest as was the need of tree-planting under the circumstances adverted to, it was not easy to effect the work. The very magnitude of it was as discouraging as its necessity was imperative. What could the planting done by a few settlers amount to on those wide seas of verdure, treeless and shoreless? Driven by necessity, as we have said, they did, many of them at least, plant their little groves of cottonwood and other quick-growing but frail trees around their cabins. These gave some shelter to the cabins and their inmates. But what was to shelter the cattle and the crops? The hap-hazard efforts of a few, working here and there without concert, easily spent themselves in attaining results far short of what were needed.

It was the happy fortune of one living as a pioneer in the treeless region of the West, not only to feel with those around him the evils of their peculiar situation, but to devise an instrumentality which would arouse an interest in the needed work and an enthusiasm for it

that would convert the necessary labor, to a large extent, into pleasure —at least take from it the character and irksomeness of a drudgery. The plan was, to fix upon a particular day, at the season of the year when the trees are starting into fresh life, and to invite those in the same general region to engage together on that day in the work of tree-planting. The designation of a particular day had the effect to prevent the propitious season of planting from slipping by unobserved, while it had also the advantage and stimulative effect attendant upon co-operative endeavor. The thought of tree-planting was thus at a certain time made as it were to pervade the atmosphere, or rather, perhaps, to become an atmosphere.

Thus Arbor-day, or Tree-planting-day, originated, and the person who put the question, not long since, in the columns of one of our newspapers, "Who invented Arbor-day?" used the right word. We commonly apply the term invention to some machine or mechanical contrivance. But there is no reason for thus restricting its meaning. Arbor-day is as truly an invention as the cotton-gin or the steam-engine, and, like those notable inventions, its importance and beneficial results will be recognized in increasing measure with the lapse of years. Governor Morton builded better than he knew when he gave origin to this day. He was thinking chiefly of his own State, Nebraska, of beautiful name, but swept by the fierce blizzards of the Northwest and the hardly less harmful sirocco-blasts from the torrid South. He was contriving a plan to raise up against these harmful agencies the effective barrier of the leafy trees. His plan commended itself at once to his fellow-citizens, and in the first year of its adoption more than ten million trees were planted. Nor was the happy invention limited in its application by the boundaries of a single State. The people of neighboring States and Territories, with similar needs, one after another, adopted it, until it may be said to have become a fixed institution throughout the prairie region of the country.

But Arbor-day is not for the treeless regions of the West alone. The principle of associated and simultaneous action which it embodies commends it for adoption almost everywhere. States where once the trees were so abundant as to be in the way of agricultural improvement, and to call for the axe and the fire to remove them as speedily as possible, or where their value for lumber had occasioned their rapid and general displacement, are now welcoming Arbor-day to assist them in regaining the condition which they lost by the inconsiderate destruction of their best friends. Thus Michigan, lately a wilderness of forest, and even yet sending to market annually more lumber than any other State, but becoming sensible of the need of trees for other use than to be converted into lumber, has made experiment of Arbor-day, and in his designation of the 11th of April last, by public proclamation, Governor Alger earnestly recommended that on that day "we plant trees by the road-side, by our farm-houses, in our fields, parks,

villages, and cities, around our school-houses, and in the cemeteries where sleep our beloved dead. . . . We may not live," he said, "to enjoy the full fruits of this work, but our children and our children's children will receive the benefit of our labor."

Pennsylvania, in keeping with that wise consideration of the value of trees which led William Penn to prescribe, among the early laws of his colony, "that, in clearing the ground, care be taken to leave one acre of trees for every five acres cleared," has followed Michigan in the recent adoption of Arbor-day.

The older Northern and Eastern States have not the same interest in forestry as the prairie States. They are comparatively well-wooded. Yet, even among them, such have been the encroachments upon the woodlands by the axe and by fire as seriously to affect the flow of streams, and the manufacturing and agricultural interests dependent upon them. In several of these States attention has been called to the subject, and its manifest importance has led to legislative action looking to the protection of what forests remain and to the planting of new ones. Most of the New England States are now engaged in the serious investigation of their forestral condition. The boards of agriculture have taken it into consideration, and some of them have urged the adoption of Arbor-day as an instrumentality of importance to the interests of the States.

Thus the Arbor-day idea is seen to have spread far beyond the place of its origin. It has been formally adopted already by seventeen of our States, and bids fair to be adopted soon by many others.

A noticeable and important development of the Arbor-day movement is its connection with the public schools. This may be said to date from the memorable tree-planting by the pupils of the public schools of Cincinnati, on the occasion of the meeting of the American Forestry Congress in that city in the spring of 1882. No one who was present will ever forget the scene, when, on a lovely May day, twenty thousand school-children, marshaled by their teachers, formed a part of the grand procession which, amid banners fluttering from every window, and with the accompaniment of military battalions and bands of music, went out to the beautiful and well-named Eden Park, and there, in Authors' Grove, planted trees in memory of the most eminent authors and statesmen of our own and other lands. It was a lesson in practical forestry and of practical education at the same time. It was a grand and impressive object-lesson of the best character, and one that reached far beyond the circle of those immediately engaged in it. If the children were taken out among the trees for a holiday, the trees were thenceforth and thereby brought into the schools of Cincinnati, and the sweet influences of Nature connected with the school-room and its studies as never before. That holiday was made a most impressive and valuable school-day. It was for the

time the school in the open air, face to face with Nature and her most healthful and instructive agencies.

It was only a little while after that scene in Cincinnati that the superintendent of the schools of West Virginia, moved alike by a desire to arouse a proper sentiment in behalf of forestry and to promote the interests of education, signalized his administration by designating an Arbor-day and inviting its special observance by the schools of the State. His appeal met a ready response, and the day was widely observed.

And by all means should Arbor-day invite the children to engage in its observance. It was a most happy thought to connect the schools with it and thus enlarge its scope. It was so, whether we consider the interests of forestry or the interests of education. The pupils in the schools to-day will soon be the men and women, the householders and citizens of the country, holding its character and destiny in their hands. They will be all-powerful. It is most important, therefore, that they should come into their influential place in society prepared to use their influence in the best manner and for the best ends. And this is to be secured by the best training in their school-days; such a training as will fit them to deal wisely with the facts and conditions of practical life. Their education should be so conducted as to be not a drudgery but a delight. And this it will be made, if the mind of the pupil is engaged with objects which interest it, with objects close about it, rather than those far away and with which it has no concern. Set the child to study the geography of his own town, or first his own school-house grounds, instead of that of Kamchatka, and he will be interested. Engage him in noticing the forms of the trees that grow about the school-place—the birds, the flowers, the rocks which he sees every day—and his mind will become all alive with interest in them. They are akin to his own nature. He lays hold of them as by an instinct. Give him these objects of study in place of much of the customary task-work of arithmetic and grammar, for instance, and you inspire within him such a loving and ardent desire of knowledge, and such an awakening of faculties, that the world around him will be his school-room so long as he lives, in which he will be studying to the last, and in which he will find perpetual delight. It is sad to know that so much of our school-time has been and still is wasted, and that the children so frequently have come out from the place of education, as it is called, with so little knowledge of the world in which they live and in which they are so soon to occupy positions of influence and responsibility.

There are no studies in which the young are so much interested as those which relate to the natural world, and there are none which better serve the purpose of disciplining the mind for the work of coming life. The general adoption of Arbor-day, therefore, and its connection with our schools would be a pleasant starting-point for the

introduction into them of the natural sciences with all their healthful and helpful influences.

And just here, also, if we mistake not, is our best guarantee for the promotion of forestry and for the solution of a great national problem. The children, who have been invited and assisted to plant shrub and tree on their school-house grounds, will soon be interested in the work of their elders, as they plant trees along the borders of the streets, and will ask to join in it. Next, they will be ready to assist in bringing trees, with which it may be sought perhaps to give the village cemetery a more pleasant look; or they will enter with sympathy into the work of converting some neglected spot of ground into a comely park, or clearing up a rough piece of woodland so as to make it a desirable place of resort and recreation. Thus, going on from year to year, a new generation will soon have come to manhood and womanhood, a generation full of the love of trees as such, and not estimating them merely for their value as lumber or cord-wood. They will even have a poetic sensibility in respect to the trees. Like the old Greeks, they will sometimes people the woods and groves with dryads, or, as our ancestors did, with gnomes and sprites. They will have learned, also, as their fathers have not, the important relations which the forests sustain to climate, to the precipitation and distribution of moisture from the sky and clouds, and its exhalation from the ground. They will be sensible of their influence upon the hot and cold currents of the air, and their value to agriculture by serving as effective barriers against them. They will have learned, as their fathers have not, how nicely adjusted to each other are the forces of the natural world, and how hazardous it is to disturb their equilibrium, yet how easily in our ignorance or recklessness we may do it. The fact will be familiar to them that the woodman, by an improvident use of his axe upon the hill-side, may let loose the torrent or the avalanche, which may hurl ruin upon the fertile valley below. Well knowing these and many other things respecting the trees, of which the present generation for the most part are ignorant, or which they are slow to learn, the new generation will recognize, as we do not, that the trees are essential to man's highest welfare, that they are his best friends, that they are the constituted partners of the world with him, that human life in fact would be impossible without them. Recognizing these facts, as the new generation come into society as its directors, we may expect that they will be conservative of the forests, and thus conservative also of the best interests of the country.

SKETCH OF SIR JOHN BENNET LAWES.

IN JOHN BENNET LAWES, said "Nature," more than ten years ago (December 9, 1875), "we have a private individual who, unaided by the state, or by any scientific body, has made a greater number of useful experiments than all the experimental farms of European governments put together." The work referred to in such terms of praise was performed on Mr. Lawes's private estate at Rothamstead, in Hertfordshire, England, to which he succeeded as heir in 1822, being eight years of age, and on which he began his famous experiments in 1834, when he entered upon actual possession of it.

Mr. Lawes was born in 1814, and acquired his school education at Eton College and Brasenose, Oxford, where he was a student from 1832 to 1835. His favorite work during this time was in the laboratory; and after leaving the university he spent some time in London, in the study of practical chemistry. His situation and surroundings were particularly favorable to his giving his whole attention to the pursuit to which his tastes inclined him, and for which he had qualified himself by his studies. Possessed of independent means, a handsome property, and a beautiful old manor-house and domain of about five hundred acres, he at once interested himself in agriculture; and from the year he entered upon manhood till now, or for more than fifty years, he has been unceasingly applying his scientific knowledge to the solution of questions affecting the practice of that art. "In the commencement of his experiments," says his biographer in the London "Times," "among other subjects, the effect of bones as a manure on land occupied his attention for some time. A friend and neighbor, the then Lord Dacre, particularly directed his notice to the fact that bones were very variable in their effect on different soils. Several hundred experiments were accordingly made, some upon crops in the field and others with plants in pots, in which the constituents found in the ashes of plants as well as others were supplied in various states of combination. Striking results were gained from these experiments, in which the neutral phosphate of lime in bones, bone-ash, and apatite was rendered soluble by means of sulphuric acid, and the mixture applied for root-crops. The results obtained on a small scale in 1837–'39 were such as to lead to more extensive trials in the field in 1840–'41, and to the final taking out of a patent early in 1842. This being done, Mr. Lawes established large works in the neighborhood of London, for the manufacture of superphosphate of lime, by which name the manure is known, which has produced such a revolution in the science of agriculture."

In 1843 Mr. Lawes associated with himself Dr. J. H. Gilbert, whose name has since been connected with his in all the researches

prosecuted at Rothamstead, as a practical chemist; and together they undertook a series of agricultural investigations in the field, the feeding-shed, and the laboratory. The laboratory was at first located in an old barn; but in 1854, when the friends of Mr. Lawes proposed to present him a service of plate in recognition of their appreciation of his work, he suggested that a new laboratory building would be a more appropriate and enduring as well as useful testimonial, and the money was applied for the purpose of erecting one.

The place, identified with Mr. Lawes's experiments, Rothamstead, the patrimonial estate of the investigator, is situated some twenty-five miles from London, in Herts, and is easily accessible to visitors from the Harpenden Railway station. The manor-house is described as being a remarkably fine specimen of Old English architecture, while the domain surrounding it contains some magnificent timber, including an avenue of lindens, which, for size and regularity of dimensions, are perhaps unsurpassed in the south of England. Around the family mansion lie the five hundred acres that form the experimental station, which is entirely maintained by Sir John. For the benefit of the large number of laborers whose services are required in the management of the station, Mr. Lawes many years ago formed an allotment club through which small gardens of about an eighth of an acre each can be rented. For this purpose, in 1882, sixteen acres of land had been allocated, and the whole number of allotment gardens then in cultivation was one hundred and seventy-four. The allotment area is furnished with a club-house.

The scientific discovery, says an English biographer, around which all Mr. Lawes's subsequent work centered was the disprovement of Liebig's mineral-ash theory. It was generally supposed at the time his experiments were begun that certain saline bodies, so-called mineral constituents, were essential to the growth and development of the plant, and that such substances must be furnished to it by the soil. The necessity of a certain quantity of nitrogen was recognized; but it was imagined, since wild plants could thrive without any artificial supply of nitrogen, that a sufficient amount of that element existed in the atmosphere to render it unnecessary to take any steps for increasing the supply. The cardinal discovery made by Mr. Lawes of the absolute necessity of the presence of nitrogen in the soil in order to maintain its fertility was a contradiction of this view, and led to the opening of a new field of agricultural investigation. In connection with the belief in the sufficiency of the atmospheric sources of nitrogen, it was supposed that the fertility of a soil might be maintained for an indefinite period if the different mineral constituents carried off by the crop were annually returned in due quantity as mineral manure to the soil. Respecting these two points, and regarding the sources of nitrogen, Mr. Lawes has said: "I maintain that the amount of nitrogen supplied to our crops from the atmosphere, whether as combined

nitrogen brought down by rain or that absorbed by the soil or the plant, constitutes but a very small proportion of the total amount they assimilate, and that the soil itself (or manure) is practically the main source of their supply. Indeed, it is a question whether on arable land as much or more may not be lost by drainage or otherwise than is supplied by the atmosphere." The field experiments on which these conclusions rest have formed Sir John Lawes's principal work. Favored by position and circumstances, he has been enabled to carry out on a large scale most important operations. His general plan has been to select fields in a condition of agricultural exhaustion, that is, in a state in which a fresh supply of manure was needed to fit the soil for the growth of another crop. Upon this exhausted soil each of the most important crops in the rotation was grown year after year upon the same spot, in plots without manure, and in other plots in which various kinds of manure, but usually the same to each, were applied yearly. Thus it became possible to determine the point of relative exhaustion or excessive supply of any of the constituents of the manure. The details of this method are given an exemplary explanation in Mr. Lawes's "Report of Experiments on the Growth of Barley for Twenty Years on the Same Land," published in 1874, when the experiment was still in progress. The field had been divided into plots of about one fifth of an acre each. Some of these had never received any manure during the twenty years; the others received some one or more of the food constituents which barley requires. Thus, one was manured with phosphates, a second with alkalies, a third with ammonia, a fourth with ammonia and phosphates, a fifth with ammonia, phosphates, and alkalies, etc., every year in succession. At harvest the crops were carefully weighed, and were then analyzed in the laboratory under the superintendence of Dr. Gilbert, when the amounts of dry matter, ash, and nitrogen, were determined.

"The advantages of this systematic mode of experimenting," says an English review of the report, "are very great. Carried on in the same manner for so many years, these experiments answer questions relating to the exhaustion of the soil, to the permanent effect of manures, to the effect of season upon the produce. With the aid of the laboratory investigations they teach us what proportion of the various ingredients supplied in the manure is recovered in the crop, and how the composition of the plant is affected by the various conditions of the soil. In conjunction with analyses of the soil and of the drainage-water, we learn what becomes of the manures supplied, how deeply they have penetrated into the soil, what is the loss suffered through drainage, etc. A single field experiment, thus thoroughly and patiently carried out, touches half the domain of agricultural chemistry, and supplies information of the most solid and valuable kind."

Mr. Lawes addressed himself with great skill and success to the task of perfecting the methods of analysis; but, even after all his in-

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vestigations, he believes that the elucidation of agricultural principles must be looked for from a due consideration of vegetable physiology as well as chemistry, and of the special functional peculiarities and resources of different plants as well as their actual percentage composition. The explanation of the distinctive functions of crops grown in rotation is found, in his view, in the character and length of life of the different plants; in the character of the roots in regard to number, size, etc., and to their aptitude to derive more of their food and moisture from the surface, or from the subsoil; and in the greater capacity of some for liberating and assimilating food not available for others, or for arresting food which would otherwise be washed out of the soil. In brief, his investigations have embraced researches into the exhaustion of soils, including experiments on crops; on the principles of rotation and fallow; on the mixed herbage of grass-lands; on the progress of vegetation generally, including researches on the action of manures; on the origin of nitrogen in plants; on the feeding and fattening of cattle, and generally on stock as meat-producing and manure-making machines; on rainfall and drainage; on botanical characteristics; and on the chemistry of the malting process, and the comparative value of malt and barley as food for cattle. Mr. Lawes also, in conjunction with Professor Way, acted upon a royal commission from 1857 to 1865, in the investigation of the effect of the application of town sewage upon grass and other crops; and in the institution of comparative experiments on the feeding qualities of the differently grown crops, to be determined by the amount of increase yielded by oxen, and the amount and composition of the milk yielded by cows.

In 1872 Mr. Lawes announced his intention of placing in trust his laboratory and experimental fields, with an endowment of £100,000, the interest of which, after his death, should be applied to the continuance of the investigations carried on there. "It is seldom," "Nature" remarked, in noticing the fact at the time, "that we have to record an act of so great munificence directed in a channel calculated to bring about such important results to the scientific departments of agriculture."

Mr. Lawes was elected in 1854 a Fellow of the Royal Society, whose royal medal he received conjointly with Dr. Gilbert in 1867; he has also received a gold medal from the Imperial Agricultural Society of Russia; in June, 1881, the Emperor of Germany by imperial decree awarded the gold medal of merit for agriculture to him and Dr. Gilbert jointly, in recognition of their services for the development of scientific and practical agriculture; and in May, 1882, Mr. Lawes was created a baronet, and became Sir John Bennet Lawes. He is also a Fellow of the Chemical Society, and an LL. D.

The results of the Rothamstead investigations of Sir John Lawes are to be found in the journals of the Royal Agricultural Society, the reports of the British Association, the Journal of the Chemical So-

ciety of London, the Transactions of the Royal Society, the Journal of the Society of Arts, the Journal of the Horticultural Society of London, the "Edinburgh Veterinary Review," the reports of the Royal Dublin Society, the "Philosophical Magazine," the "Agricultural Gazette," the "Chemical News," and in official reports and scattered pamphlets and newspaper letters.

Of the value of Sir John Lawes's work at Rothamstead as a whole, we find the judgments recorded in scientific reviews of its results, that "it is not to be equaled by that of any of the foreign stations; indeed, in several departments of investigation it might safely challenge comparison with their united efforts"; and that "he has obtained a larger body of facts in relation to manures and cropping, and the feeding of animals, than all the agricultural societies in the empire put together."

We also find some lessons suggested by it in the same reviews, the bearing of which seems to have escaped the notice of the reviewers themselves, for they forthwith proceed to draw from them the opposite conclusions to the true one: "The whole is the work of the man himself. He has had no aid from the Government or any agricultural society, and no advice from any committee or public body." "Of the indebtedness of science to Mr. Lawes's unique and costly experiments we need not speak, the facts are so plain that they speak for themselves. Nor need we state the moral. The addition to the national wealth which has accrued from the discoveries made by Mr. Lawes is already enormous. It must be borne in mind that this benefit has arisen from *accidental* researches, for Mr. Lawes was not compelled to take them up, nor is he bound to continue them."

The secret of this great merit is also given; for while Mr. Lawes has not had an unqualified success, especially in drawing inferences from his facts, "his writings afford ample evidence of great earnestness of purpose. His manly, outspoken language shows that he loves truth for its own sake. He has had ample resources; and he has had the motive of self-interest, as well as love of knowledge, to stimulate him in his investigations."

In this splendid example, as in so many others, we have illustrated anew the fact that the best scientific results and the most important advances in discovery are the fruit of earnest individual work, prompted by love of the pursuit and carried on in a spirit of self-reliance; that investigation can and will make its own paths and find its way to its own ends, and be more vigorous and active for the effort; and that the time has not yet come when, in Anglo-Saxon countries, science has so declined that it must be coddled by official patronage.

EDITOR'S TABLE.

A CASE IN MORAL EDUCATION.

IT is encouraging to observe, by the recent discussions in Congress, that there is a deepening conviction of the need of an international copyright law to put a stop to the scandalous robbery of those foreign authors who are doing so much to sustain and elevate our intellectual life. There are evinced a growing sense of reprobation of this practice, and much greater agreement than ever before, both as to the necessity of putting an end to it, and the means to be adopted for the purpose. The committee was addressed by but one downright opponent of international copyright, and he admitted that he was opposed to all copyright, and would take away the legal protection of their literary property from American authors. Mr. James Russell Lowell, President of the Copyright League, made an excellent address, putting the whole question on the high moral ground of the rights of men to property in their brain-work, and the outrage of allowing other men to appropriate it from mercenary motives and because they find it valuable; and he did not hesitate to say that the reasoning by which international copyright was there opposed was but a virtual defense of pocket-picking. We call attention to this matter here simply to show that there is an undoubted quickening of the moral sense of the community over this question, so that what was long regarded with indifference as but a venial wrong is now reprobated as a practice so bad that it can be no longer tolerated.

And even while the question is being thus debated, there comes a fresh and flagrant instance of that spoliation of foreign authors which will continue to be perpetrated until the law lays its hand upon men destitute of any restraining moral sense. The case is peculiarly aggravated in this respect. A foreign author writes a valuable book, which is found especially useful in this country for cultivating the minds of teachers; and their sense of obligation to him for his great service is expressed by a virtual conspiracy among them to steal it. Mr. James Sully, of London, is the author of the "Outlines of Psychology." The work was created by his labor. It was made at the cost of time, faculty, and blood; he consumed his vital energy in preparing it just as much as is done in producing any other piece of work of any kind that was ever constructed. If there be such a thing as property, Mr. Sully's book was his property by every principle of justice and right. That was recognized by his American publishers, who made an arrangement with him to pay a royalty on the sales at an equal rate that it is customary to pay American authors. The arrangement was doubly valid in the eyes of all honorable men, for it was intrinsically just and equitable and was voluntarily made without any compulsion of law.

Mr. Sully's work was a large textbook of general psychology, but it gave prominence to the bearings of that science upon theoretical and practical education, and this was the feature that was specially appreciated by our educators. It was an obvious suggestion that to separate the educational part of the book from its connections and issue it separately in a cheaper form would be a desirable thing. Different parties, in fact, applied to the publishers to get the job of cutting the book down; but they answered that this was a matter belonging entirely to the author. He was written to, and, approving the plan, engaged to make a compend of his work

for the use of teachers and to do it at once; and it was widely advertised by the American publishers that an authoritative abridgment of the "Outlines of Psychology" by the author himself would soon appear. It need hardly be said that the author, who knew the subject thoroughly, and had created the work, was the most competent man to prepare from it a briefer volume, which would require much adaptation and new statement; because justice to teachers and to a most important subject could not be done by merely ripping out mechanically a part of the larger book and printing it separately. But Principal Reinhart, of the Paterson High-School, paid no attention to any such consideration. He cut out what he wanted from the volume, added some notes, and applied to Messrs. Appleton to print it, which of course they declined to do; and he then found another publisher to carry out his very questionable project.

Now, our only concern here is with the moral complexion of this affair, in connection with what goes for "higher education" in the public-school system of this country. A great deal is said about the low state of moral education in our public schools; but the grave question arises as to the competency of the directors of even our "high-schools" to teach it. Moral education is a matter of principles applied to practice; it inquires into the grounds of right and wrong in conduct, with a view of determining what things are proper to do and what are forbidden as immoral or unjust. It aims simply to ascertain and enforce upon the individual right rules for the guidance of personal action in daily and practical life. The obligations of morality are clear enough; what is wanted in the schools is the explanation of their fundamental importance, their sacredness, the sophistry by which they are evaded, and their pointed application to the conscience of the young.

Is the Principal of the Paterson High-School, a fit person to give such instruction? Could he explain to his classes the moral difference between stealing Mr. Sully's book and stealing his watch? Could he explain to his Jersey students why they should not steal the paper and binding of Bardeen's volume as he has its contents? If he should say to them that paper, ink, and binding are sacred things and not to be appropriated without payment, while the soul of the work, the part sought and prized as a power in our education, has no value which he is bound to recognize, would they not be justified in replying to the argument by throwing the book at his head? The Principal of a high-school who, at this time, will appropriate literary property which he has no moral right to touch, who will rob an author simply because he is helpless and must intrust his book to the public honor, and who will mutilate a work which he knows the author is himself revising and making over for the specific objects recognized—such a Principal may comply with the State standard of competency to control a high-school, but, in our opinion, he is not fit to give instructions in moral education.

The Paterson Principal will, of course, have his excuses. He may say: "The appropriation of foreign books is a common thing; it is done, and has been long done, by respectable people; I am no worse than they are." But this will not do. When a professional literary freebooter says: "I care nothing for the rights of foreign authors; I propose to take their works as long as I can profit by them and keep out of jail; 'what are you going to do about it?'"—his case is not a proper precedent for the principal of a high-school charged with the duty of forming the moral characters of pupils committed to his charge. He is to teach them that what is intrinsically wrong is not made anything else because others indulge in it. Of course, he can quote many bad examples which

he has followed, but he is among those who pre-eminently have no business to follow bad examples, either in practice or in precept. But the Paterson Principal will search a long time before finding a precedent as bad as that which he himself has set. He goes voluntarily into the business of robbing foreign authors when nearly everybody else is trying to stop it; he cuts up his book at his own caprice while the author is himself revising and condensing it; and then he plots with other educators to secure the adoption of the dishonest edition, to the exclusion of the honest and superior book. Such things might be expected of a sordid and unprincipled huckster in the publication business, but they are to be reprobated in the principal of a high-school. That he is backed by other teachers does not help the matter, but only still further exemplifies the lax and dull state of mind in regard to right and wrong which they thus evince, and which goes far to explain the backwardness and neglect of moral education in our schools.

STABILITY IN SYSTEMS OF THOUGHT.

In the "Commercial Advertiser" of January 14th there is an able article, evidently from the master-mind of that journal, on Spencer's evolution philosophy, which, from the interest of the questions raised, as well as its very decided views, deserves some critical notice. After passing encomiums on Mr. Spencer for his noble and disinterested aims, the comprehensiveness of his work, his immense results considered as an intellectual achievement, his painstaking industry, and indefatigable persistency of purpose, the writer remarks that, admirable as it all is, it still has about it "a touch of the pathetic." Not that it may never be finished, as many fear, but that, even if completed, it will quickly take its place among the systems of futile speculation with which the human mind has teemed for these thousands of years. After referring to the sad experience of Buckle, the writer says: "Mr. Spencer's case is different; he may be able to finish his work, but the view of it that comes to us is, that when it is finished it may prove, in scope and substance, no more than a brilliant dream. The theory of evolution, in the construction of which he has spent so many laborious days and nights, lavished such wonderful powers of observation and generalization, and exhibited such an ingenuity of fancy, collecting such masses of knowledge and scintillating such flashes of suggestion, will, after all, share the fate of other merely speculative fabrics, and, like them, in spite of a certain color of science which he has been enabled to give it, fade away in the advancing light of real knowledge."

We can not help thinking that this judgment manifests an imperfect appreciation of the intellectual revolution which marks off ancient and mediæval from modern thought, in so far as this represents a new era of science. It can hardly be contended that science in the present state of its development counts for nothing in its influence upon systems of thought; nor is it difficult to see in what way it acts and must increasingly act in future to discredit or to conserve such systems. The old schemes of speculation and schools of philosophy ran their transient course under the influence of great teachers, and then declined and gave place to others, because they had no basis in any real knowledge of Nature. In metaphysics and religion, the two great spheres of mental activity, imagination went riot for lack of restraining data. They had no element that could give them permanent value; one man's opinion was as good as another's, and systems multiplied with the common and inevitable character of instability. Some were preserved by favoring accidents. The system of Plato, as intrin-

sically worthless as the rest, lived on as a power in the world of thought because of the ingenuity of his speculations, the impressive beauty of their literary forms, the vitality of classical superstition in later ages, and because his system of ideas has been supposed to favor the fundamental beliefs of Christian theology.

But modern thought made a new starting-point when it began formally to build on the verities of Nature. A new element was then introduced into philosophy which was capable of giving it permanence. The discovery of the laws of motion, for example, was an intellectual acquisition to stand forever. When it was proved that the earth is not the stationary center of the universe, but only a revolving planet, there was given, not only a new fact for all time, but a fact that shattered whole systems of pre-existing opinion, and became a permanent element to fix and regulate the future thinking of mankind. In further instance, the discoveries of the circulation of the blood, of the laws of nutrition, of the double action and reflex functions of the nervous system, revealed facts of enduring moment which threw new light upon the nature of man. The establishment of the indestructibility of matter, and that all mutations of material things are governed by this law, was a new key to the understanding of our world which can never be lost. And when the kindred truth of the conservation of energy, or that in the known course of Nature force is never created or destroyed—which Faraday pronounced to be "the highest law in physical science that our faculties permit us to perceive"—when this mighty principle was demonstrated, whole systems of speculation were undermined, whole realms of previous error were destroyed, and the philosophical interpretation of Nature was put upon a new and indestructible basis. We have given a few illustrations of that element which it was the destiny of science to contribute, and by which it has formed a new epoch of thought; but all the sciences are full of this new element. It consists of contributions of fact and law standing in everlasting contrast with the baseless and transient assumptions of philosophers for the past two thousand years. But the two thousand years of empty philosophical speculation got a mighty headway; and, as our education is still dominated by tradition, the cultivated mind of the age, saturated with the "history of philosophy," remains blinded to the profound significance of that revolution of ideas which modern science has introduced. There are plenty of men whose culture is so full of the past that they are sure to go on spinning systems fanciful and futile as their predecessors; but such work is certain to become more and more anomalous and less and less regarded. For, with the development of science, there has come a new mental culture. Science forms habits of thought. Pursued in its true spirit it enforces a special discipline in the study of truth. It corrects credulity by a wholesome skepticism; it affirms the supremacy of personal observation, and demands caution in forming conclusions. All these requirements are repressive of that wanton exuberance of imaginative invention in which speculative genius is so prone to indulge. The system-maker of these times must *know* something, must build upon previous acquisitions, or he will neither be listened to by the present nor have a hold upon the future. The rapid growth of science in these days proves that its education and its disciplines have not been without effect, and it is not to be questioned that its method is gradually extending into all the spheres of mental activity. There is here a new element of stability in intellectual constructions of which nothing was known in all the historic epochs of speculation.

The writer in the "Commercial"

says that the theory of evolution which Mr. Spencer has elaborated with such ingenuity "will share the fate of other merely speculative fabrics," and "fade away in the advancing light of real knowledge." The implication of course is that Mr. Spencer's work lacks the character of "real knowledge," and this the writer confirms by speaking of "a certain color of science" which he has been enabled to give it. This is a strange deliverance. A system born of science, and constructed warp and woof out of the accredited facts and truths of the sciences, is not well described as having imparted to it a superficial coloring of science. Mr. Spencer's allegiance to facts, his comprehensive grasp of the results of science, and his command of the scientific method and fidelity to it, are unchallenged. His system, given out in fragments favorable for the most critical examination, has been under fire for twenty-five years, and has extended in influence and steadily risen in consideration in a scientific age because it was recognized to embody more "real knowledge" than any other such system ever before presented. The writer in the "Commercial" thinks he sees indications that it is already declining; he merely misinterprets the subsidence of opposition.

The simple fact of the case is, that Mr. Spencer was the first to deal with evolution as a strictly scientific problem. He withdrew it from the field of fanciful speculation, and subjected its investigation to the rigorous conditions of analytic and synthetic science. The time had come when, by the laws of advancing intelligence, the subject had to be taken up from this point of view. Its fundamental datum was given by Huxley in a few words. "It is now established, and generally recognized," said he, "that this universe and all that it contains did not come into existence in the condition in which we now see it, nor in anything like that condition." It is therefore self-evident that changes have taken place by which one condition of things has led to another and a different condition of things. Mr. Spencer took up the inquiry at this point by asking, What are the laws of these changes? It was an inquiry into the order of the phenomenal world and therefore strictly scientific in its nature, as not a step could be taken toward its solution except by the inexorable application of scientific methods. Postulating those universal and fundamental laws of scientific inquiry, the indestructibility of matter and force, the changes that have taken place had to be investigated as transformations by which one thing is derived from another, and the present evolved out of the past under that inflexible principle of all scientific inquiry, the law of cause and effect. Beyond doubt, one of the great secrets of the rapid acceptance of the doctrine of evolution by the best-trained minds of the age is the thoroughly scientific character of the exposition in Spencer's system. It has the stability of a great law of Nature, fortified by results from all the sciences, and can only pass away as it is further developed under the principle of evolution, which itself gives law to the progress of knowledge; and the attempt to kick it into the limbo of speculative vagaries implies, as we have said, some considerable misapprehension of the situation.

LITERARY NOTICES.

GRAY'S BOTANICAL TEXT-BOOK. Sixth edition. Vol. II. PHYSIOLOGICAL BOTANY. 1. Outlines of the Histology of Phanerogamous Plants; 2. Vegetable Physiology. By GEORGE LINCOLN GOODALE, A. M., M. D., Professor of Botany in Harvard University. New York and Chicago: Ivison, Blakeman, Taylor & Co. Price, $2.

THE first edition of Gray's "Botanical Text-Book" was published forty-three years ago, and took the highest rank at once as an American exposition of the science, both for college uses and for students generally.

With the rapid development of the science successive editions appeared, each for the most part rewritten, the fifth edition coming out in 1857. But botanical science at length outgrew the possibility of dealing with it in any adequate way in a single volume. This led to the necessity of completer treatment in several connected works. Professor Gray says in his preface: "To secure the requisite fullness of treatment of the whole range of subjects it has been decided to divide the work into distinct volumes, each a treatise by itself, which may be independently used, while the whole will compose a comprehensive botanical course."

The first volume of this series was written by Professor Gray, and entitled "The Structural and Morphological Botany of Phanerogamous Plants." It deals chiefly with organography, or the account of the structures and forms of the organs of plants, and, as the author remarks, "should thoroughly equip a botanist for the scientific prosecution of systematic botany, and furnish needful preparation to those who proceed to the study of vegetable physiology and anatomy, and to the wide and varied departments of cryptogamic botany" which are to be dealt with in the subsequent volumes of the series.

The second volume of this work upon "Physiological Botany" (vegetable histology and physiology), the treatise now before us, was written by Professor Goodale, the colleague of Professor Gray, and Professor of Botany in Harvard University, and is "devoted to a consideration of the microscopic structure, the development, and the functions of flowering plants; that is, to their vegetable histology, organogeny, and physiology." The volume is divided into two parts, the first taking up and pursuing with great thoroughness the subject of histology, or the minute microscopical structure and elements of plants. An introduction is devoted to "Histological Appliances," or the instruments of the botanical investigator—such as microscopes, dissecting implements, reagents, etc. Cells and tissues, in their structures, contents, compositions, and modifications, are then taken up in a general way, to be followed by the minute structure and development of root, stem, and leaf, flower, fruit, and seed. Elementary structures being mastered, the pupil then proceeds, in Part II, to the investigation of their functions, or physiological botany proper. Physiology considers the plant in action, the changes occurring in its multitudinous parts, the constituents involved, the products generated, the interactions of the vegetable organism with soil and air, the movements of plants, vegetable growth, germination, and reproduction.

What chiefly strikes us, in looking over this interesting volume, is the immense advance that has been made in late years in the elucidation of the laws of the internal vegetable economy. There has been a large increase in the resources of investigation, the skillful experience with which it is conducted, and a great amount of new light has been thrown upon the obscure and subtile processes of vegetable organisms. Vegetable physiology has been brought far more completely within the grasp of the experimental method than would have been thought possible thirty years ago. It has become laboratory-work, as established and necessary as in the case of chemistry or physics. It follows from this that to the thorough study of physiological botany not only microscopical observation but manipulatory exercises of various kinds are quite indispensable. It was formerly supposed that the physiology of plants was a subject to be mainly read about, and the knowledge of it derived from books, without much possibility of a direct and real acquaintance with the facts, but that view must now be abandoned. We observe with interest and great satisfaction that Professor Goodale has been fully alive to the educational implications of this circumstance, and has made his volume a working text-book by which the student is enabled and required to make the knowledge of the subject his own. Those who faithfully go through the work will not only acquire a mastery of the facts, and a thorough acquaintance with what is known of the processes of vegetal life, but they will gain a valuable training in the conditions of scientific method and the difficult and important art of scientific investigation.

We can not close this slight and very unsatisfactory notice of a most important book without some cordial recognition of

the obligations of American scientific men and American teachers to the life-long and invaluable services of Professor Gray in the elaborate revision of his text-books which have now taken so comprehensive and complete a form in this series. With the patience and perseverance of the true scientific enthusiast, he has confined himself to his own line of work, and taken authoritative possession of the botanical field in this country. By securing the co-operation of other men whom he has assisted to qualify for the work, Professor Gray gives to his undertaking a solid and permanent value which will make it influential upon the growth of American botany for many years to come.

FRENCH DISHES FOR AMERICAN TABLES. By PIERRE CARON (formerly *chef d'entremets* at Delmonico's). Translated by Mrs. FREDERIC SHERMAN. Pp. 231. D. Appleton & Co. Price, $1.

THIS may not be "the cook-book of the future," but, what is more to the purpose, it is a pretty good cook-book for the present. Written by a man and translated by a woman, it ought to be full of the duplex-cellences implied by its double origin. At any rate, the man understood the business of cooking, and the woman understands the business of translation; and so the man's full and accurate knowledge of culinary operations is made as simple and clear to the reader as plain, well-chosen language can make it. The book contains six hundred receipts, and it is said the quantities are all calculated for tables of eight persons. We have heard that this book has been tried with marked success.

RAILROAD TRANSPORTATION: ITS HISTORY AND LAWS. By ARTHUR T. HADLEY, Commissioner of Labor Statistics of the State of Connecticut, Instructor in Political Science in Yale College. Pp. 269. New York: G. P. Putnam's Sons. Price, $1.50.

THE laying down of an iron track on leveled ground, whereby vehicles could carry heavier loads, and the attachment of steam-machines instead of animals to draw the vehicles were mechanical novelties in their time which many could not fail to see were full of new possibilities, but nobody even suspected the tremendous implications of the steps that had been taken. He who saw the first car moved by steam upon a tramway, and hauling a load of stone, may also have lived to see an express train of palace-cars, with a meeting-house full of people, shooting along with the proverbial swiftness of the pigeon, "a mile a minute." This result shows the astonishing rapidity of the development of the art of locomotion, and always impresses the observer with wonder at the triumphs of invention, and the new conquest over space and time that may be shared by everybody.

And yet all this is but the superficial aspect of the railroad dispensation upon which we have entered. The discovery has been gradually made that the railroad system is a new social power, the destiny of which is to force to such a solution as they may be capable of receiving a large number of fundamental questions relating to industry, commerce, the laws of competition, individual rights and corporate prerogatives, the operation of natural laws in society, and the compass and limitations of legislative authority. These problems are forced upon the community by the development of railroads, as they could have been in no other way. They *must* be met and acted upon, if not with far-seeing intelligence, then with short-sighted ignorance; and as the results of experience disclose themselves—good or bad—we shall have a large and instructive example of that compulsory education which originates in social conditions and the nature of things.

It is somewhat from this point of view that the timely and admirable book of Professor Hadley has been prepared. It is not at all a treatise on the railroad in itself, and is not to be ranked with books of construction, improvement, and railway management that are made for the uses of railroad-men. It is rather a book on the *relations* of railroads to the community, and therefore deals with a class of subjects in which all citizens are interested. The writer's point of view is thus briefly indicated in his preface: "This book deals with those questions of railroad history and management which have become matters of public concern. It aims to do two things: first, to present clearly the more important facts of American railroad business, and

explain the principles involved; second, to compare the railroad legislation of different countries, and the results achieved. The two things need to be viewed in connection with one another. The attempt to manage railroads without regard to the demands of public policy, or to legislate concerning railroads without regard to the necessities of railroad business, results in disastrous failure. This fact has been gradually recognized by thoughtful men on both sides."

To meet this view of the subject, Professor Hadley has written his volume, which, for popular use, is beyond comparison the most instructive and valuable railroad-book that we have seen. It is a work which ought to be very generally read; for there is a great deal of ignorance, prejudice, and passion among many people in regard to railroad management, which would be dispelled if the matter were better understood—a result to which the perusal of this volume will certainly lead. The author writes neither in the blind interest of railroad corporations, nor of the people as a class victimized by these corporations, but in the light of facts and principles to which both must bow. It may be added that the volume is one that will be read with much pleasure, from the freshness and variety of its information on the latest results of railroad experience.

THE PHILOSOPHY OF EDUCATION: OR, THE PRINCIPLES AND PRACTICE OF TEACHING. By T. TAIT, F. R. A. S. Pp. 331. New York: E. Kellogg & Co. Price, $1.

THIS seems to be a kind of general treatise on the art and mystery of school-keeping, and was evidently reprinted, as the editor intimates, because of "the growing desire for treatises on education." It contains a great deal of information about schools and teaching, and various parts of it will prove suggestive and useful, but it is a good deal behind the age. Originally published in 1837, it represents the state of thought in the early part of the century; and its psychology, the vital point in any educational work that proposes to deal with principles, is completely outgrown and discredited, as editor Traub acknowledges. But, after all, most teachers, notwithstanding all the progressive talk about psychology, are still deep in the old dispensation of "mental philosophy," and will therefore find themselves much at home with this volume.

RATIONAL COMMUNISM. The Present and Future Republic of North America. By a Capitalist. New York: The Social Science Publishing Company. Pp. 498. Price, $1.50.

THE capitalist author presents in this work a plea and a scheme for a new social organization. His ideas are said to be the outgrowth of a vision, in which, lifted high in the air, he saw New York, Brooklyn, Long Island, etc., newly laid out and peopled on an ideal plan adapted to promote the equal wealth, standing, and happiness of all. Coming back to the reality, he finds things organized to promote inequality and not happiness. He then proceeds to develop his plan, in which he aims to avoid the particular rocks on which all the social communities hitherto projected in this country have been severally wrecked.

THE WILL: A NOVEL. By ERNST ECKSTEIN, author of "Quintus Claudius," etc. From the German by Clara Bell. Authorized edition. In two volumes. New York: Gottsberger.

THE will here intended is not that mental element sometimes known as volition, but a document of an entirely material nature, which meant not only fortune to the hero of the story but name and titles as well. Like so many other modern novels, the tale winds in and out among socialists and their doings and beliefs, although it can scarcely be called a partisan book. The attempt seems to have been expository of the workings of that order of beliefs and feelings, which seems to lend itself to dramatic treatment with as remarkable success as the grand passion itself.

ON THE HEATING AND VENTILATION OF DWELLINGS AND SCHOOL-ROOMS. By CHARLES O. CURTMAN, M. D., St. Louis. Pp. 10.

THIS is a reproduction of a paper that was read before the American Public Health Association. It presents a careful review, with suitable illustrations, of the operation, merits, and demerits of all the methods of house-heating in current use, with especial reference to their adaptability to school-rooms.

JOINT-DISEASES: TREATMENT BY REST AND FIXATION. Pp. 15. SURGICAL TREATMENT OF INFANTS. Pp. 12. By DE FOREST WILLARD, M. D. Philadelphia.

DR. WILLARD holds that rest subdues joint-inflammation more effectually than all other means combined, and that the more perfect the rest the greater will be the diminution of pressure, tension, and inflammation, and of their resultant ankylosis and suppuration. The pamphlet contains the arguments in support of his views and descriptions of the appliances, and their applications, by which he secures the rest he prescribes.

The second paper is an address which was read in June of last year before the Philadelphia Obstetrical Society. The author believes that the surgery of childhood, as compared with that of adult life, is, aside even from congenital defects, sufficiently marked and distinctive to entitle it to separate consideration. Even the anatomy of the child can not be learned from the ordinary adult dissections during a college course, but the surgeon must make himself specially acquainted with it. References are made, in the course of the address, to classes of cases in which special treatment and applications may be called for.

THE PREHISTORIC PALACE OF THE KINGS OF TIRYNS. By Dr. HENRY SCHLIEMANN. New York: Charles Scribner's Sons. Pp. 385, with Chromo-lithographic Plates, Map, and Plans. Price, $10.

THE citadel of Tiryns is one of the most ancient ruins in Europe. The city which it represents had its origin and probably its whole existence in prehistoric times. It is treated in Homer's "Iliad" as a place whose greatness was of the past, while Mycenæ was still vigorous and Argos rising. Its massive remains or "cyclopean walls," standing some eighty feet above the sea back of the Gulf of Nauplia, were regarded as a miracle in ancient days, and have been objects of wonder to Greeks, Romans, and moderns, for twenty-five hundred years. Dr. Schliemann having attacked, with more or less of satisfaction in the result, Troy, Mycenæ, and Orchomenos, it was natural that the attention of the great archæologist should be directed to their rival in antiquity and in association with the legends of the heroic age. His work at Tiryns has been rather more successful than at the other places he has explored, because he has gone at it with the benefit of acquired experience, and has been able to perform it more systematically and in such a way as to insure the preservation of everything. He has laid bare the whole plan of the palace and fortress, with all of its most important details, and has given the means for forming a clear idea of how those Herakleid or Perseid Greeks lived. The palace was reached by a winding carriage-way duly guarded with gates, the thresholds, bolt-holes, and pivotal hinge-holes of which, and the ashes of the wooden parts, are still visible. The plan of the palace was elaborate, and reveals a grouping around two centers, the hall of the men and the hall of the women, communication between which was only indirect. The walls were adorned with paintings in animal and geometrical designs, and plaques of alabaster with designs in blue-glass paste, fac-similes of which are given in the colored plates of the book. One of the most remarkable features of the building was the bath-room, which was floored with a single slab of stone of eight by ten feet, that can not weigh less than nineteen tons. Within this room was found a fragment of the terra-cotta tub in which the heroes took their baths. The arrangements for drainage and the whole plan of the palace show a considerable advance in civilization, when, as we have been accustomed to believe, civilization had hardly begun on that spot. The excavations, to which Dr. Schliemann had given his personal attention, were continued while he was preparing his account, during 1885, by his collaborator, the distinguished German archæologist, Dr. William Dorpfeld. He made a series of new discoveries hardly less interesting than those which had already been made. Among them are the facts that the huge stones of which the walls were built were not absolutely rude, but were roughly hewed and shaped for their purpose; that the walls were built with clay mortar, which has been washed away in all the exposed portions; and that these walls, which are of great thickness, have chambers within them to which access

was had by galleries, the use of which had previously been a puzzle to the explorers. We have also in Professor F. Adler's preface, in which the writer makes comparisons between the ruins of Tiryns and other monuments of prehistoric Greece, and deduces the significance in some points of the whole, a few suggestions which open to us new conceptions of the capacity and arts of the heroes. Many of the blocks of the upper citadel must weigh from 12,000 to 15,000 kilogrammes—even middle-sized stones weigh from 3,700 to 4,000 kilogrammes — and their transport, to their exact place on a high and rocky site, was only possible with the aid of many technical devices and a host of workmen. These figures prove that the citadel can not have been built in a hurry, in the sight of an enemy, or as the first stronghold of an invasion based on maritime supremacy. In fact, "the colossal walls tell every one able to read the language of stones that their erection can only have been effected in a long period of peace, by a ruler with unusual sources of power, and who had trained workmen under his permanent control." There are other facts that point to these buildings being second structures on the site; and, reviewing all the sites, "a real primitive architecture is nowhere to be found; even in Troy the first steps of development are long past. Within certain limits, the materials are already under control, and worked variously, according to the available means and the ends required. A moderate but yet very fruitful store of detail forms is already gathered, so as to cover the gradually elaborated shapes of rooms with significant adornments full of meaning. In some peculiarly favored places, the domain of the higher monumental architecture has already been entered upon with decisive success. In the face of such extended and yet closely connected achievements, which form a consistent whole, the attempt to search for the roots from which arose this early bloom of the art of building is doubly attractive." Other suggestions may be found relative to the development of forms of architecture in stone from models afforded by the primitive wooden structures, and to the connection of this early European with already old Egyptian art.

BRAIN-REST. By J. LEONARD CORNING, M. D. Second edition. New York: G. P. Putnam's Sons.

THIS little book, which may be regarded as a supplement to the same author's treatise on "Brain Exhaustion," published by D. Appleton & Co., and already noticed in the "Monthly," deals with the important question of the reinvigoration of the brain after exhausting mental labor or after disease. Dr. Corning has made a special study of the subject, and his book contains many facts and suggestions which brain-workers may find of service, and by the help of which they may be able to avoid or remedy to some extent the great danger to which their method of life exposes them.

REPORT OF THE COMMITTEE OF THE CITIZENS' ASSOCIATION ON THE MAIN DRAINAGE AND WATER-SUPPLY OF CHICAGO. J. C. AMBLER, Secretary: Rooms, 35 Merchants' Building, Chicago. Pp. 32.

THE report shows that the water-supply from the lake is always liable to contamination from sewage entering the lake anywhere within the present district. Hence, all sewage whatsoever in this district should be diverted from the lake as its outfall. The flood-waters of the Desplaines and the North Branch may be diverted to the lake north of this district, or through Lake View township, and the South Fork may be connected with the lake by a conduit. But the main reliance for drainage should be by conveyance to the Illinois River. The general plan suggested by the committee may be carried out step by step, to the gradual improvement of the sanitary condition, and without creating a debt or requiring an extraordinary tax-levy.

NATIONAL CONFERENCE OF STATE BOARDS OF HEALTH. J. N. MCCORMACK, of Kentucky, Secretary. Pp. 63.

THIS pamphlet, which is a reprint from the Report of the Illinois State Board of Health for 1885, contains an account of the organization of the Conference in connection with the meeting of the American Public Health Association at Detroit, Michigan, in November, 1883, and the reports of its first meeting at St. Louis, in October, and the adjourned meeting, at Washington, in December, 1884.

THE ANNALS OF THE CAKCHIQUELS. The Original Text, with a Translation, Notes, and Introduction. By DANIEL G. BRINTON, M. D. Philadelphia. Pp. 234. Price, $3.

THIS is the sixth volume of Dr. Brinton's "Library of Aboriginal American Literature." In the editor's estimation, on account of both its historical and linguistic merits, the document which it presents is one of the most important in the class to which it belongs. "Written by a native who had grown to adult years before the whites penetrated to his ancestral home, himself a member of the ruling family of one of the most civilized nations of the continent and intimately acquainted with its traditions, the work displays the language in its pure original form, and also preserves the tribal history and a part of its mythology, as they were current before they were in the least affected by European influences." The translation is made directly from the orignail text. The Cakchiquels were a nation of somewhat advanced culture, who lived within the area of the present state of Guatemala, and spoke a language related to the Maya. They were agriculturists and skillful builders, and had a picture-writing. The present work takes up the history of the tribe during the latter part of the fourteenth century, and brings it down to abont 1559. It was introduced to public notice by the Abbé Brasseur de Bourbourg, and Dr. Brinton's translation is made from his copy.

THIRD ANNUAL REPORT OF THE BUREAU OF ETHNOLOGY, 1881–'82. By J. W. POWELL, Director. Washington: Government Printing-Office. Pp. 606, with Plates.

THE plan of the work of the Bureau of Ethnology, of which this volume covers one year, contemplates the direct employment of scholars and specialists to conduct investigations and prepare the results for publication; and the stimulation and guidance of research by collaborators who voluntarily contribute the results of their work for publication or other use. Papers were published during the year covered by the report in Volume V, of "Contributions to North American Ethnology," on cup-shaped and other lapidary sculptures, "Prehistoric Trepanning and Cranial Amulets," and the Maya (Yucatan) "Manuscript Troano." The field-work of the year embraced the researches of Mr. Cushing among the Zuñis, with the labors of other observers in that tribe and among the Pueblos; researches by Mr. Gatschet among the Katábas in South Carolina, Mrs. Erminnie A. Smith among the Iroquois, Dr. W. J. Hoffman among the Indians at Fort Berthold, Dakota; and "Mound Explorations." Subjects bearing upon linguistics and related branches have been studied and elaborated in the office of the Bureau. In the present volume are included as "accompanying papers," and constituting the greater part of its bulk, "Notes on Certain Maya and Mexican Manuscripts," by Cyrus Thomas; "Masks, Labrets, and Certain Aboriginal Customs," by William H. Dall; "Omaha Sociology," by J. Owen Dorsey; "Navajo Weavers," by Dr. Washington Matthews; "Prehistoric Textile Fabrics of the United States, derived from Impressions on Pottery," by W. H. Holmes; and catalogues of two collections—one from mounds and one from Arizona and New Mexico—made during 1881.

MODERN MOLDING AND PATTERN-MAKING. By JOSEPH P. MULLIN, M. E. New York: D. Van Nostrand. Pp. 257.

THIS is designed to be a practical treatise on pattern-shop and foundry work, and embraces the molding of pulleys, spur-gears, worm-gears, balance-wheels, stationary engines, and locomotive cylinders, globe-valves, tool-work, mining machinery, screw-propellers, pattern-shop machinery, and the latest improvements in English and American cupolas, together with rules and tables for every-day use. Everything is given, in all of its details, as the result of the author's own careful study and actual personal experience, and, he says, "I have simply narrated the work of my hands."

A DICTIONARY OF MUSIC AND MUSICIANS. Edited by GEORGE GROVE, D. C. L. Parts XX and XXI. New York: Macmillan & Co. Pp. 256. Price, $1.

THESE numbers embrace the titles from "'Tis the Last Rose of Summer" to "The Water-Music." Among the longer articles are one on "Variations," "The Violin," "Violin-Playing," and ample biographical sketches, with accounts of their works, of Verdi, the Abbé Vogler, and Richard Wagner.

THE JOURNAL OF PHYSIOLOGY. Edited by MICHAEL FOSTER, with Co-operators in England and America. Vol. VI, Nos. 4 and 5. American Agency with Professor H. Newell Martin, Johns Hopkins University. Baltimore: Pp. 156, with Plates. Price, $5 a volume.

THE "Journal of Physiology" is the recognized register of physiological research by English-speaking investigators, and presents as they are accumulated the results of the studies of those distinguished experimentists, on either side of the ocean, whose discoveries have been the means of contributing so much to the intelligent and efficient treatment of human affliction. The present number contains papers by G. F. Yeo and J. W. Barrett, S. Ringer, H. Sewall and D. W. Steiner, J. A. McWilliam and T. Wesley Mills, on various aspects of the heart; S. Ringer and D. W. Buxton, on contractile tissue, etc.; C. S. Sherrington on the spinal cord of the dog; E. F. Herroun and G. F. Yeo, on "The Sound accompanying the Single Contraction of Skeletal Muscle"; and transcripts from the Proceedings of the Physiological Society, 1885.

REVISION OF THE PALÆOCRINOIDEA. Part III. First Section. By CHARLES WACHSMUTH and FRANK SPRINGER. Philadelphia: William P. Kildare, Printer. Pp. 138, with Eight Plates.

HARDLY any kinds of fossils are more attractive to the collector than the crinoids, with their endless variety of forms, each distinguished by its peculiar style of beauty and grace; and hardly any other kind offers a richer reward to the searcher for specimens who is so fortunate as to find a bed of them. Since the first part of this work was published, some five years ago, great progress has been made in the study of both the recent and fossil members of the order, and many new and interesting forms have been discovered and described. The authors of the monograph confess that their own knowledge of the subject also has grown. The present section of the work includes a discussion of the classification and relations of the Brachiate crinoids, with generic descriptions. A second section is promised in the "Proceedings of the Philadelphia Academy of Natural Sciences" for 1886, to contain the Articulata and Quadrinata.

THE PUBLISHED WRITINGS OF ISAAC LEA, LL. D. By NEWTON PRATT SCUDDER. Washington: Government Printing-Office. Pp. 278.

THIS is Bulletin No. 23 of the United States National Museum, and is the second of a series of bibliographies of American naturalists which the Museum is publishing. Dr. Lea is our oldest conchologist, and is one of the most laborious and fruitful devotees in that branch of research that our country has had. He is still living, in his ninety-fourth year, and blessed with good health and unimpaired mental and physical faculties. The list of his publications, as given in this work, with full descriptions of each, includes 279 titles. His cabinet of *Unionidæ* in Philadelphia displays about ten thousand individuals, of different ages, so arranged that each may be separately examined, and it is unique in having many species arranged with a sequence from the youngest to the oldest, so that the student may see at a glance the aspect of their growth.

BULLETIN OF THE SEDALIA NATURAL HISTORY SOCIETY. Sedalia, Mo. No. 1, August, 1885. F. A. Sampson, Corresponding Secretary. Pp. 30.

THE society was organized January 14, 1884, and has been able to report a year and a half of successful operation. This first number of its "Bulletin" contains its constitution and by-laws, list of officers, and acknowledgments of contributions; together with papers on the "Shells of Pettis County," by F. A. Sampson, and "Pettis County Pentremites," by Dr. G. Hambach.

BULLETIN OF THE MINNESOTA ACADEMY OF NATURAL SCIENCES. Volume II. No. 5. C. W. Hall, Secretary, Minneapolis, Minn. Pp. 84.

THE present number of the "Bulletin" includes papers from May, 1881, to December, 1882, the publication of which has before been unavoidably delayed. Among the more important papers are a report "On Some Tests of Building-Stones," by J. A. Dodge; a report on the "Mineralogy of the State, with Notes on the Bibliography of the Subject," by N. H. Winchell; and "Meteorological Statistics of Minneapolis for Eighteen Years," by William Cheney.

THE SYSTEM OF HIGH LICENSES: HOW IT CAN BE MADE SUCCESSFUL. By G. THOMANN. New York: The United States Brewers' Association. Pp. 36.

THE imprint of this publication indicates the point of view from which the subject is considered. The paper is a plea for discrimination in the imposition of licenses in favor of what are called the lighter drinks. The author cites, in support of his views, from the records of licensing and liquor-selling in Switzerland and various places in Germany.

AN IRON CROWN: A TALE OF THE GREAT REPUBLIC. Chicago: T. S. Denison, 1885. Pp. 560. Price, $1.50.

IN the course of this story the attempt is made to show the dangers to free government threatened in the growing abuses of corporate power. It deals with millionaires, mining, railroads, etc., and takes the side of the people against the "daring freebooters who would seize the people's rights."

THE FIXED IDEA OF ASTRONOMICAL THEORY. By AUGUST TISCHNER. Leipsic: Gustav Fock. Pp. 86.

WE several months ago noticed the book by this author, "The Sun changes his Position in Space, therefore he can not be regarded as being in a Condition of Rest," in which the competency of the present astronomical system is attacked because it is based on the assumption of a fixed sun. In the present work the author postulates a new theory which takes the motion of the sun into account.

FREE CITIES IN THE MIDDLE AGES. By L. R. KLEMM. Hamilton, Ohio. Pp. 22.

THIS paper, which was read before a local literary and scientific society, is after the German of G. F. Kalb, and sketches one of the most remarkable and interesting phenomena of modern history—the development and life of those free communities which maintained a prosperous and independent existence amid the degradation and conflicts of mediæval times, holding their own against the military barons and princes who would have crushed them if they could, and whose part was most important in preserving civilization and giving life to industry and art.

BULLETINS OF THE UNITED STATES NATIONAL MUSEUM, No. 28. A MANUAL OF AMERICAN LAND-SHELLS. By W. G. BINNEY. Pp. 528. No. 29, RESULTS OF ORNITHOLOGICAL EXPLORATIONS IN THE COMMANDER ISLANDS AND KAMCHATKA. By LEONHARD STEJNEGER. Pp. 382, with Eight Plates.

THE "Manual of American Land-shells" appears as an enlarged and revised edition of "The Land and Fresh-water Shells of North America, Part I," which was published by the Smithsonian Institution in 1869. Subsequently described species are added. Fuller attention is given in separate chapters to the subjects of geographical distribution, organs of generation, jaw and lingual dentition, and classification. In description, the species are grouped geographically rather than systematically. The work was prepared with Mr. Thomas Bland, who died in August, 1885, as co-author. The monograph by Mr. Stejneger is the first attempt to present a complete list of the birds known to have been observed in Kamchatka. It is divided into three parts, consisting of a review of the species of birds collected or observed by the author in the Commander Islands and at Petropaulski, a synopsis of the birds reported to inhabit Kamchatka, and conclusions. The second part is given to make the account of the birds of Kamchatka as complete as possible.

RECEPTION DAY, No. 4. New York: E. L. Kellogg & Co. Pp. 156. Price, 25 cents.

THIS is a collection of fresh and original dialogues, recitations, declamations, and short pieces for practical use in public and private schools. The compiler has aimed to have the pieces short, easy to be comprehended, infused with life and spirit, fitted for average pupils in the schools, and free from double-meanings and all that can verge on impropriety or vulgarity.

NOTES ON THE OPIUM-HABIT. By ASA P. MEYLERT, M. D. Fourth edition. New York: G. P. Putnam's Sons. Pp. 49.

SOME additional data relative to the treatment of the habit have been inserted in this edition; and the author gives the result of his investigations on the administration of cocaine hydrochlorate as a specific.

PUBLICATIONS RECEIVED.

The Monthly Index. Vol. I, No. 1. Bangor, Me.: Q. P. Index. P. 1. 25 cents a year.

The Relations of Mind and Matter. By Charles Morris. Pp. 100.

Function: Its Evolution and Influence on Organization. By C. N. Pierce, D. D. S. Philadelphia. Pp. 11.

Chronological List of Scientific Books and Papers. Pp. 16. Address to the Department of Pharmacy, State University of Iowa. Pp. 8. By Gustavus Hinrichs. Iowa City, Iowa.

Journal of the Trenton Natural History Society, Trenton, N. J. Vol. I, No. 1. Pp. 22.

Bowlder Mosaics in Dakota. By Professor J. E. Todd. Pp. 4, with Plate.

Household Receipts. Boston: Joseph Burnett & Co. Pp. 68. 25 cents.

Report on Drainage of Mystic, Blackstone, and Charles River Valleys, Massachusetts. Boston: Wright & Potter Printing Company. Pp. 243, with Plates and Maps.

Monthly Catalogue. United States Government Publications. Nos. 9 and 10. Washington, D. C.: J. H. Hickey. Pp. 20 each. $2 a year.

The Bizarre Notes and Queries, January, 1886. Manchester, N. H.: S. C. & L. M. Gould. Pp. 28. $1 a year.

South Pass Jetties. Pp. 87, with Maps. Letters to the Mississippi River Commission. Pp. 14. By James B. Eads. New York.

Illinois State Board of Health, Annual Meeting, 1886, Report of Proceedings. Springfield, Ill. Pp. 66. Decisions under Medical Practice Laws. Pp. 44. Conspectus of Medical Education. Pp. 138.

Hallucinations in Inebriety, etc. Pp. 20. States of Delirium in Inebriety. Pp. 7. By T. D. Crothers. Hartford, Conn.

Oxygen: Its Place in Therapeutics. By S. S. Wallian. New York. Pp. 30.

The Truth-Seeker Annual. New York: Truth-Seeker Office. 1886. Pp. 106. 25 cents.

Georgia Department of Agriculture, Supplemental Report of 1885. Atlanta: J. P. Harrison & Co. Pp. 52.

Directors' Report, Harvard Astronomical Observatory. Pp. 13. Early Experiments in Telegraphing Sound. Pp. 7. By Edward C. Pickering. Cambridge, Mass.

Transactions of the State Medical Society of Wisconsin, 1885. Dr. J. T. Reeve, Secretary. Appletons. Pp. 170.

Reports on Electric Signal and Registering Apparatus. Philadelphia: Franklin Institute. Pp. 96, with Plates.

Technical Instruction in Europe. By Charles O. Thompson. Washington: Government Printing-Office. Pp. 55.

The Western Society of Psychical Research. J. E. Woodhead, Secretary. Chicago. Pp. 8.

Hearing and Deafness. By F. G. Riley, M. D. New York. Pp. 16.

Lunar Irregularities due to the Action of Jupiter. Washington: Bureau of Navigation, Navy Department. Pp. 20.

Quarterly Report of the Bureau of Statistics to September 30, 1885. Washington: Government Printing-Office. Pp. 241.

Report of the Industrial Education Association, New York, 21 University Place. Pp. 31.

Guide to Buyers and Sellers of Real Estate. By George W. Van Sicklen. New York. Pp. 58.

Report of the Prison Association of New York on Convict Labor. W. M. F. Round, Secretary. Pp. 15.

The Tehuantepec Ship Railway. By Elmer L. Corthell. Pp. 80. Proceedings of a Public Meeting at St. Louis. Pp. 28.

An Infidel's Plea for Christianity. By C. M. Clark. Seward, Neb. Pp. 16.

Western North Carolina as a Health Resort. By Henry O. Marcy. Boston. Pp. 24.

Extracts from G. von Rath's Notes on the Bement Collection of Minerals. Pp. 11. Meteoric Iron from Jenny's Creek, West Virginia. Pp. 4. By George F. Kunz. New York.

The Louisiana Purchase. By Bishop C. F. Robertson. New York: G. P. Putnam's Sons. Pp. 42. 50 cents.

The Theories of Ore Deposits. Pp. 14. The Keweenaw Series, etc., of Michigan. Pp. 9. By M. E. Wadsworth,

Transactions of the New York Academy of Sciences. Vol. III. 1883–'84. Pp. 186. Vol. V, Nos. 1 and 2. Pp. 73. $3 a year, or 40 cents a number.

Journal of the Cincinnati Society of Natural History, January, 1886. D. L. James, Secretary. Pp. 64, with Plate.

Transactions of the Anthropological Society of Washington. Vol. III. Smithsonian Institution. Pp. 204.

Hampton Institute: Its Work for Two Races. Hampton, Va. Pp. 34.

Diccionario Tecnológico, English-Spanish, No. 15. New York: N. Ponce de Leon. Pp. 116. 50 cents.

Cephalopoda of the Cincinnati Group. By Professor Joseph F. James. Cincinnati. Pp. 20, with Plate.

Catholic Historical Researches. Edited by the Rev. A. A. Lambing. Wilkinsburg, Allegheny County, Pa. January, 1886. Pp. 40. $1 a year.

Manual Training-School, Washington University, St. Louis. 1885–'86. Pp. 45.

Revista di Artiglieria e Genio (Review of Artillery and Engineering), December, 1885. Rome. Pp. 246.

John Cabot's Landfall in 1497, and the Site of Norumbega. By E. N. Horsford. Cambridge: John Wilson & Son. Pp. 41.

Evolution and Religion. By Henry Ward Beecher. Part II. New York: Fords, Howard, & Hulbert. Pp. 440. $1.

The Spartan and Theban Supremacies. By Charles Sankey. Pp. 231. The Early Hanoverians. By Edward E. Morris. Pp. 235. New York: Charles Scribner's Sons. $1 each.

Introduction to the Study of Chemistry. By Ira Remsen. New York: Henry Holt & Co. Pp. 387. $1.40.

Class Interests. Their Relations to Each Other and to Government. By the author of "Conflict in Nature and Life." New York: D. Appleton & Co. Pp. 172.

The New Agriculture. By A. N. Cole. New York: The "American Angler." Pp 223. $2.

Mechanics and Faith. By Charles Talbot Porter. New York: G. P. Putnam's Sons. Pp. 295. $1.50.

Rationalism in Medical Treatment. By William Thornton. Pp. 46.

Mineral Resources in the United States. Reports for 1883 and 1884. By Albert Williams, Jr. Washington: Government Printing-Office. Pp. 1016.

History of California. By Theodore H. Hittell. Vol. I. San Francisco: Occidental Publishing House. Pp. 799. $5.

Oceana, or, England and her Colonies. By James Anthony Froude. New York: Charles Scribner's Sons. Pp. 396. $2.50.

Mechanical Integrators. By Professor Henry S. H. Shaw. New York: D. Van Nostrand. Pp. 212. 50 cents.

Household Remedies. By Felix L. Oswald. New York: Fowler & Wells Company. Pp. 229.

My Ten Years' Imprisonment. By Silvio Pellico. New York: Cassell & Co. Pp. 200. 10 cents.

Before Tilsit. By Count Leon Tolstoi. New York: W. S. Gottsberger. Two Vols. Pp. 322 and 357. $1.75.

History of Alaska. By Hubert Howe Bancroft. (Works, Vol. XXXIII.) San Francisco: A. L. Bancroft & Co. Pp. 775.

Marlborough. By George Saintsbury. New York: D. Appleton & Co. Pp. 219. 75 cents.

A History of German Literature. By W. Scherer. Translated by Mrs. F. C. Conybeare. Edited by F. Max Müller. New York: Charles Scribner's Sons. Two Vols. Pp. 401 and 425. $3.50.

Easy Lessons in German. By Adolphe Dreyspring. New York: D. Appleton & Co. Pp. 103. 70 cents.

Problems in Philosophy. By John Bascom. New York: G. P. Putnam's Sons. Pp. 222.

Popular Government. By Sir Henry Sumner Maine. New York: Henry Holt & Co. Pp. 261. $2.75.

Delsarte System of Dramatic Expression. By Genevieve Stibbins. New York: Edgar S. Werner. Pp. 271. $2.

The Determination of Rock-forming Minerals. By Dr. Eugen Hussak. Translated by Erastus G. Smith. New York: John Wiley & Sons. Pp. 283. $3.

Elements of Psychology, with Special Applications to the Art of Teaching. By James Sully. New York: D. Appleton & Co. Part I. Pp. 130. 25 cents.

Outlines of Psychology. With Special Reference to the Theory of Education. By James Sully, M. A., Examiner in the University of Cambridge, etc. Reading-Club edition. Abridged and edited, with Appendices, Suggestive Questions, and References to Pedagogical Works, by J. A. Reinhart, Principal of the Normal Training-School, Paterson, N. J. C. W. Bardeen: Syracuse, N. Y. Pp. 372. $1.50.

POPULAR MISCELLANY.

The Real Nature of "Prodigies."—Mr. C. F. Cox has published, in the "Journal" of the New York Microscopical Society, a most interesting paper on "The So-called Prodigies of Earlier Ages." He believes that the stories of wonderful phenomena and portents with which the old books abound have a certain interest and value to the student and philosopher of to-day, "because they furnish landmarks in the progress of observation, and give us clews to that credulous state of the human mind which seems to have necessarily preceded the foundation of inductive reasoning." Themere historian of scientific discovery will also find in them what he must believe to be truthful statements of facts, mingled with distorted and erroneous interpretations and many unintentional misstatements of what were thought to be facts; and he may employ himself with some profit in separating the true from the false. Mr. Cox cites from a variety of books, particularly from Wolffhart's illustrated "Chronicle," a large list of wonderful appearances, which he divides into thirteen classes, for each of which he finds a particular way of accounting with an approach to satisfactoriness. Thus, the sweating and weeping of images, altars, etc., may be regarded as exaggerated cases of the condensation of vapor upon them. The bleeding of stones, shields, etc., was most probably the growth of the red lichen upon them, though it may in some cases have been rust. Showers of earth, chalk, ashes, etc., hardly need accounting for; and rains of brimstone may have been clouds of pollen, spores, or other yellow vegetable products. Showers of oil were probably not showers at all, but marks of supposed showers in the shape of greasy spots on the earth or stones or plants, or iridescent films on water; the appearance is sometimes produced by the growth of gelatinous protophytes, like the nostocs. The flowing of oil in brooks, etc., is also accounted for, as it would always be now, as a case of iridescence. Stories of showers of milk may have originated in the appearance of white spots, generally caused by growths of fungus, on leaves. The flowing of milk from the earth, in streams, etc., might be in most cases the superstitious interpretation of so simple a fact as the mixture of calcareous earth with ordinary running water; or, under favorable conditions, some of the lower forms of life might multiply so enormously as to give a milky hue to considerable bodies of water, as they do constantly under our own observation in a smaller way. The spotting of bread, grain, leaves, stones, etc., with blood, is a phenomenon easily accounted for by a very slight knowledge of the various forms and habits of the red and orange-yellow fungi. The flowing of blood in the ocean, rivers, springs, etc., is to be accounted for in some instances by the presence, in unusual quantities, of red algæ. "Showers of blood" may be referred to similar algæ; or deposits referable to such showers may be produced, as was known to be the case at Aix-la-Chapelle in July, 1608, by butterfly-chrysalides undergoing transformation, when large drops of a blood-colored liquid exude from them. Red snow is known to be a protococcus. "Showers of flesh"—one occurred in Kentucky in

1875, and was so accounted for—may occur when buzzards, having gorged themselves with carrion, disgorge it as they fly in the air. "Thus easily"—in the Kentucky case it was the flesh of a horse, and the buzzards were seen—"was a modern prodigy disposed of; and quite as rationally, we now see, might we dispose of all ancient prodigies which were not mendacious fabrications, if only we could catechise witnesses and apply scientific methods to the examination of such facts as were found to remain."

Study out of School.—On the question of study out of school-hours, Mr. L. W. Parish, of the Iowa State Teachers' Association, maintains that education should look to the most natural, complete development of physical, mental, and moral qualities. Neither side should be preferred at the expense of another, but all three should be developed hand in hand. To secure the proportionate and therefore most effective training of the intellectual powers, little or nothing is required, during the first three or four years of school-life, which a skillful and faithful teacher can not accomplish without forcing book-work upon the children during the evening hours, or during the time that belongs of right to physical development, or the performance of home duties. But, that the work may be done thus, unfavorable circumstances must be removed, and both pupil and teacher must do their parts. The pupil must be regular and industrious, and the teacher must show herself mistress of the best methods of presenting topics of instruction. On account of some irregular and unwholesome influences operating upon schools, more out-of-school study than is necessary or good is demanded, but an intelligent co-working of teachers, parents, physicians, and the local press ought to cause a steady decrease of it, and an increase in systematic physical and moral training.

The Search for the Trans-Neptunian Planet.—Mr. David P. Todd, of the Lawrence Observatory, Amherst, Massachusetts, has published a memoir on his search for the trans-Neptunian planet. He uses the definite article—the—in speaking of this body, hypothetical though it still may be, because he regards the evidence of its existence as well-founded, while, during all the time he has been engaged in the search of it, nothing has weakened his conviction of its existence in about that part of the sky he has assigned to it. The independent researches in cometary perturbations by Professor Forbes have furthermore conducted him to a result identical with Mr. Todd's—a coincidence, it is suggested, not to be lightly set aside as pure accident. That five years have elapsed since this coincidence was remarked, and the planet is still unfound, does not make it evident that the existence of the planet is merely fanciful, for the particular spot in which its presence is suspected has received very little scrutiny with telescopes competent to such a search. The time has now come when, by the help of the developments and improvements that have been made in astronomical photography, the search can be profitably undertaken by any observer having the rare combination of time, enthusiasm, and the necessary appliances. In aid of any such search, Mr. Todd has published a record of his observations of the indicated region, with the twenty-six-inch refractor telescope of the Naval Observatory, accompanied by exact transcriptions of the "finder" diagrams, and of diagrams showing the relative positions of objects.

Distribution of Trees in Canada.—Mr. A. T. Drummond, in a paper read before the British Association last year, on "The Distribution of Canadian Forest-Trees," ascribes an important part to the existence of large bodies of water in the eastern part of the country, and of conditions under which a much milder climate is given, with a higher range of trees, on the western side of the continent. Then, in the United States and Canada the mountain-ranges are somewhat continuous, and have a northern and southern trend, affording an opportunity to the northern trees to extend southward on their flanks, and to the southern trees to range northward in the valleys; and this has given rise to a more extended distribution than could otherwise occur. Another important element in the distribution is the chain of the lakes, which forms a barrier to the free extension into Canada of the southern forms

common in our "lake States." Nevertheless, the currents of the lakes have been the means of distributing seeds on the jutting headlands of the northern coast, where a few southern forms have been found. On the other hand, the cooling effect of such large bodies of water encourages the growth of northern species, and thus around the coasts of Lake Superior the flora includes a few semi-Arctic plants, though inland these all disappear, and the vegetation is of a more northern temperate type. Only a few trees have the faculty of making themselves at home over as wide an extent as some herbaceous plants; and these are those usually which have light or winged seeds. One reason for the different development of this faculty in trees and herbs is probably that the seeds of trees are of greater size and weight, and less easily carried away from their parent. A break in the westward extension of a considerable number of the forest-trees occurs beyond Lake Superior and Red River. This is ascribed to the greater dryness of the climate west of that lake, the effect of which is also seen in the alleged superior quality of the wood of the aspen and spruce trees. Too much moisture in the atmosphere has also its results in determining the range of trees. The same causes which prevent the range westward beyond Red River of many of the Eastern trees, also prevail in restricting the eastward range of the British Columbia trees beyond the influence of the Rocky Mountains.

Local Climates of Exposure.—Professor W. Mattieu Williams, in the "Gentleman's Magazine," quotes with approval Dr. Frankland's recommendation of elevated snow-covered districts as winter sanitariums, and adds some observations of his own. Pertinently to the subject of reflection from waters, Professor Williams notices the position of Torbay, so celebrated for its mild winter climate, as on the one part of the Devonshire coast that has the most direct exposure to the east. "It hugs the east winds that blow directly into it from the open sea, and has no protection whatever from them. Paignton is the most directly exposed and the warmest part of the bay; the next is Torquay, or rather the Paignton side of Torquay." The mildness of the Torquay climate is also promoted by favorable inclination to reflection of the early morning sun-heat of the slopes, and by the tempering to which the east winds are subjected before reaching the land. At Broadstairs "is a little sandy bay backed by cliffs and facing directly east. I have several times on a sunny day in winter-time walked along the sands from the Granville side of Ramsgate to Broadstairs, and have been much interested in observing the sudden change of climate experienced on turning the projecting cliff forming the south horn of the bay. Ladies sit on the sands there with needlework and novels in the month of December." The sea-reflection is in many cases powerfully supplemented by cliff-reflection. "When the aspect is due south, as at Hastings, it overrides it altogether. The peculiar climate of Hastings is, I think, entirely due to this, for here we have the anomaly of sea-cliffs that have been deserted by the sea, which has left sufficient fore-shore for houses to be built between it and the cliffs. In the winter these cliffs warm these houses by reflecting the southward mid-day sun; in the summer they roast them. Not only do cliffs reflect some of the sun's rays during the day, but they absorb the remainder and give it out after the sun has set. . . . Other local climatic influences may be noted; among them the effect of a stretch of dry sand above high-water mark and at the foot of cliffs."

The Quaternary Moose of New Jersey.—Professor W. B. Scott has described, before the Academy of Natural Sciences of Philadelphia, a very large extinct moose or elk, the almost complete fossil skeleton of which, now in the Museum of Princeton College, was discovered in a shell-marl deposit under a bog at Mount Hermon, New Jersey. With the exception of five caudal vertebræ, every important bone of the skeleton that is missing is represented by its fellow of the opposite side, so that it has been hardly possible to go astray in making the necessary restorations. The skeleton is of an adult but not old individual, and appears to belong to the same species with one described by Wistar, and called by Harlan *Cervus Americanus*, which, together with some metacarpals described by Leidy, is preserved in the

Academy of Natural Sciences in Philadelphia. This species can not, however, be included in any known genus, as these are at present defined, and for that reason Mr. Scott has proposed for it the name *Cervalces Americanus*. The most obvious peculiarity of the skeleton is the great length of the legs, which gives the animal a stilted appearance, while the thorax is shallow and the neck short. The shoulders are higher than the hips, as in the moose, and unlike those of the stag. The combined length of the head and neck shows that in the ordinary position of the legs the muzzle would not reach the ground by fourteen or fifteen inches. Measured in the same manner, the moose's muzzle reaches to within about ten inches from the ground, and that of *Megaceros* to eight or nine inches. This and some other features of the structure indicate that the habits of the animal, and to some degree its appearance, were those of the moose. Its short neck shows that it would have great difficulty in grazing, and so probably lived by browsing upon shrubs and trees. This was aided by a more or less prehensile upper lip, which the character of the nasal opening shows to have been more proboscis-like than in the deer, though far less so than in the moose. Morphologically, the fossil is of interest for the light which it seems to throw upon the question of the genus *Alces*, and its relations to the typical deer.

Many Drugs: Few Remedies.—In an address on "Many Drugs: Few Remedies," Dr. George K. Welch, of Keyport, New Jersey, draws a highly-colored picture of the helplessness of the average medical practice in the face of disease. The schools increase and the graduates swarm, "but how many great physicians can you name, and which are the diseases borne under the annual spring-flood of doctors; and yet, where is the young doctor who does not believe in the magic of drugs, and the old doctor, if he be a wise man, who does not look upon the most of them as mischievous, and the minority as deserving of restriction? The pathologist is skeptical of them all. With laborious zeal we study diseases. . . . We anatomize and compare, and the professor awes with learned length while he discourses of the ills he can not cure. . . . Do we, waiting behind the eye of Koch, know anything of tuberculosis, or believe that he does? Does not the ravage go on? And who has won eminence in curing yellow fever? Are men no longer in dread of cholera? And the exanthemata—does not the grewsome pendulum of disease sweep into and out of every neighborhood about once in five years? Who cures rheumatism, or typhoid fever, or chronic Bright's disease? And where is the stout heart that never failed before a patient burning and broiling in the horrible slow flame of pyæmia? And yet, who refrains from prescribing? The witches move one way about the caldron, and we go the other; they throw in the drugs that brew the poisons, and we throw in the counter-poisons. Stillé and Maisch's 'Dispensatory' has a list of one hundred and fifty remedies for rheumatism, a disease which is as likely to become chronic with treatment as without it. Everybody has a specific, from your grand-aunt with teas, fomentations, and flannel, to the last German doctor with forty grains of salycilic acid to the dose. . . . The trouble is, medical thought moves too much toward specifics." Improvement must come, partly by enforcing the responsibility of every physician to all, or by the establishment of a college of experimental medicine, with a system of registration for correcting errors of observation; or, in other words, by adopting for the study of disease the methods of the experimental physiologists.

Reform of Juries.—The causes of the decline of juries and the remedy for it are considered by Mr. Edwin Young, of the Albany bar, in a paper on "The Jury in Modern Corporate Life." The theory of the institution, that "twelve disinterested freeholders of the neighborhood, of average intelligence and virtue, are best qualified to determine issues of fact," ought, if carried out, to secure an ideal tribunal. It does not secure it, but something far different. The reason of the deterioration that has come over juries is easily found in the exemptions allowed by law, some of them really unnecessary and even improper when the true view of the case is taken, which furnish a loop-hole through which a considerable body of our best citizens escape from

service; in the abuse of the power and discretion of the court in granting excuses on the ground of "business engagements," or other trivial pretexts; in the collusion of officers to keep names off the jury-lists; and in public apathy and unwillingness to serve. Hence jury-duty has to be performed largely by persons who are not worthy of it, and who are often regardless of the obligation of an oath. "To revive its usefulness," Mr. Young says, "the jury must be purged. As an institution handed down by our forefathers, it is amply sufficient for the purposes for which it was intended. It is only in its abuse that we suffer, and that abuse can only be remedied by a revival of public spirit, and the realization of the fact that private interests are best subserved by the devotion of a part of our time to public duties."

Colored Audition.—M. A. de Rochas has published some notes on "Colored Audition," a faculty which some persons are alleged to possess of perceiving sensations of color in connection with the hearing of particular sounds. To most of the persons who have reported to him on the subject, acute sounds and the vowel *i* (French) appear red or of a brilliant color, but the variations in the matter are infinite. One lady associates its especial color with each note of the musical scale, each vowel, and each digit; and she never hears any sum mentioned without the colors of all the figures it contains passing in succession before her eyes. Another lady sees names colored—John, bright red; Joseph, very dark blue; Louis, red; Louisa, blue; and Lucy, yellow; while all names ending in *us* are green. An engineer associates a color with the name of every day of the week. To him, Monday is a gray day; Tuesday and Wednesday, white; Thursday, yellow; Friday, Saturday, and Sunday, dark-red. Most of the persons known to have this faculty have had it from infancy.

The National Museum.—By a "Handbook" just published by Ernest Ingersoll and his associates, Messrs. Taylor and Ainsworth, the National Museum at the Smithsonian Institution, Washington, is shown to be a group of most interesting and varied collections. It started with the remarkable and heterogeneous accumulation of curiosities at the Patent-Office which once formed one of the great attractions for visitors to the national capital. The Smithsonian Institution having been organized and housed, and the Patent-Office having become too full of the models and goods legitimately its own, the curiosities were turned over to the care of the Smithsonian agents. To these collections have been added from time to time—after the Centennial Exhibition, the government exhibits of other countries; the zoölogical treasures of the Fish Commission; specimens of natural resources from Territorial surveys; the mineralogical, geological, archæological, anthropological, and natural history treasures that have been gathered in the course of the Government surveys which have been systematically carried on over our whole domain; and various articles, special collections, etc., gathered from different quarters of the globe. The museum is housed in dust-proof plate-glass cases, in a building which has been constructed expressly for it, and which is described as having been filled up from the Greek cross radiating from a central rotunda into a complete square, the exterior walls of which are three hundred and seventy-five feet in length. The various collections have been scientifically and topically classified and arranged, and are accessible in the several departments of geology, mineralogy, chemistry, economic geology, and metallurgy, as representing the inorganic world; and of botany, zoölogy, anthropology, archæology, ethnology, and comparative technology, as representing the organic world; each of the departments being further subdivided according to its various branches. The museum is under the care of Dr. Spencer F. Baird as director, and G. Brown Goode as assistant director, with twenty-four curators, all but nine of whom serve without expense to it.

Poetry and Reality in Zuñi.—Dr. R. W. Shufeldt, U. S. Army, in a sketch, in "Forest and Stream," of an excursion through Zuñi-land, speaks of his entrance into the pueblo as like stepping from the pictures—which we have in the descriptions of Mr. Cushing and others—into the reality. "There were the squarish houses all piled up on one

another, and the chimney-pots and openings on the roof; there bristled up in many directions the tops of the ladders; there were the Zuñis themselves on the roofs with others in the streets, bearing on their heads the very jars, the like of which I had so often seen my artist friends in the National Museum illustrating; in short, here was Zuñi, for it has not its counterpart in all the world. At our approach a dozen dogs raised the alarm, and off scampered a group of half-naked children of both sexes with their black, negro-like heads of hair (the biggest part of some of them) blowing in the wind. Strange as it may seem, our first inquiry was, how came the hill there upon which this ancient pueblo was erected? The plain for miles about it is almost as level as the surface of a lake. Imagine the impression it made upon us when, after our examination, the undeniable fact stared us in the face that although Zuñi may have originally been started on a slight rise in the plain, yet its present elevation—between thirty and forty feet above the datum plane—is due largely in some places to the accumulated excrement of the burros, and I suspect, too, to some degree, the refuse from the houses! This condition can better be seen at the pueblo of Las Nutrias, where the entire lower stories of some of their houses are covered above their roofs by a like guano deposit, while additional stories have been built on and above them. In Zuñi this condition is more particularly the case on the side of the pueblo facing toward the missionary-house. In this situation the side of the hill has been cut away to make room for a garden, and its composition is easily studied. I am not aware that this fact has been published before; but it seems hardly possible that a thing so evident has been overlooked. We were disappointed at finding the pueblo so nearly deserted. Not more than one house in ten was occupied, as every able-bodied man and woman was at this time of the year away planting wheat, as we saw them at Las Nutrias. Upon leaving home, a Zuñi closes the little low door to his house by piling a quantity of stones up in front of it. He also takes the precaution to plaster up with clay the opening upon the roof. Such fastening is considered a sacred seal, and no honest one would think of breaking it any more than we would a seal to a letter. We saw all the empty houses closed up in this way, and it lent the pueblo a terribly deserted appearance." All of the poetry of the scene was taken out by the remark of one of Dr. Shufeldt's companions, an eminent professor, as they turned to go away, that "he had seen enough of that mass of hovels on a dung-hill, inhabited by people whose habits and customs are too frightful to think of." In fact, every law known to sanitary science seemed to be violated at the pueblo.

The Fine Arts in Burmah.—Several of the fine arts flourish to a certain degree in Burmah, although none of them are as highly developed as they are in India. Weaving is very ancient and is widely diffused throughout the country, yet the weavers of the finest and most highly adorned fabrics are foreigners, the descendants of slaves brought from Manipur. In drawing, Burmans who are trained to any art are masters of the pencil, although they have little idea of perspective or of the balance of light and shade. While the details are conventional, the general idea is the creation of the workman, and the pictures are often full of life and humor. Decoration of funeral-pyres with paintings, sometimes extremely grotesque, is an important branch of this art. Brass-founders make images of Gotama, bells of various characters, and the flat, crescent-shaped gongs which are used for religious purposes. Wood-carving has a very extensive range of variety in character. Some of the work in foliage and figures in the Buddhist monasteries is remarkably beautiful, as well in the delicacy of the curves as in the lightness and grace of the open tracery. An Institute of Industrial Arts has been established at Rangoon, to develop this industry. A curious and intricate effect is obtained in carving some articles in ivory, when "the outside of the specimen is carved with foliage and flowers, through the interstices of which the inside is hollowed out nearly to the center, where a figure is carved *in situ*. The figure looks as if it had been carved separately and inserted into a flowery bower, but closer examination shows that this is not the case, and the men may be at any time seen carv-

ing the figure through the opening of the tracery." Every village larger than a hamlet has its goldsmith and silversmith. In the filigree ornaments made by goldsmiths, the burnished gold retains its proper color, but the other gold is dyed red with tamarind-juice, a barbaric custom to which the Burmese cling tenaciously. The reason given for it is that no other metal but gold will assume this particular ruddy color when treated with tamarind-juice; it may in fact be regarded as the hall-mark of Burmese jewelry. The silver-work of Burmah is much esteemed by connoisseurs all over the world; the artists treat this metal so as to obtain the greatest possible effect that the nature of the material allows. The trade is not a paying one, but the leading artists are devoted to their art, and are quite content if they gain enough to live on, provided that they keep their position at the head of the craft. Many of them are proficient in niello-work, in which the design appears as if drawn in silver outline on a black ground.

An Earthquake Experience.—A French gentleman residing at Mendoza, in the Argentine Republic, gives a graphic description in "La Nature" of the earthquake that took place there on the 30th of March, 1885, at about half-past ten in the evening. He was reading and smoking, when one of the sashes of his window opened all at once and immediately closed again with noise. He thought a dog had come in through the window, and bent over to look for the intruder under his desk. The window opened again, and he was obliged to hold on to his desk, while his chair leaned over with him. He straightened himself again, and was thrown to the right. At the same time his jaws came together and he bit off his pipe-stem, while he felt a pain in the pit of his stomach, like that of sea-sickness. Then the thought occurred to him that it was an earthquake. Six seconds afterward he heard a noise like that of a distant locomotive letting off steam, followed by the howling of dogs and the noise of the wind through the plantain-trees. Then he saw the angle of the wall veer slowly to the left, then return to its place, so speedily that he was scared and ran to the door to get out. The door would not open. The dogs kept on howling louder than ever. He burst the door open, and, running out, found all the people in the streets, mostly in their night-dresses. Three violent shocks were felt. The writer of the account believes that a fourth shock would have destroyed the town. The sky was afterward obscured with fog; and, for thirty seconds after the last shock, a subterranean noise was heard like the rumbling of a railroad-train in the distance.

NOTES.

Sir W. Temple, in his "Essays of Health and Long Life," recommends, as the strongest preservative against contagions, a piece of myrrh held in the mouth. It has been asserted that Eastern physicians invariably adopt this protection when attending the sick.

A memorial window to the late Sir William Siemens, erected by his brother engineers, was unveiled in Westminster Abbey, November 26, 1885, with addresses by the Dean and Sir F. Bramwell.

The article by Professor Rood, entitled "The Problem of Photography in Color," published in the last "Monthly," and credited to the "Photographic Bulletin," should have been credited to "Anthony's Photographic Bulletin."

M. Pagès, in the course of his experiments in photographing the movements of horses, has been struck by the observation that the foot of the animal, being half the time at rest on the ground, must, during the other half the time, be in much more rapid motion than the animal itself. He estimates that in the gallop the foot reaches a velocity of sixty metres, or about two hundred feet, a second.

Dr. C. V. Riley, Entomologist of the Department of Agriculture, and Honorary Curator of Insects in the National Museum, has given to that institution his extensive private collection of North American insects, representing the fruits of his labors in collecting and study for many years.

The Mexican Government is said to be contemplating the establishment of a meteorological station among the highest mountains of the country, at an elevation of nearly twenty thousand feet above the level of the sea. Instruments for its use, as far as possible to go a year without stopping, are being made at Zürich, Switzerland.

"Naturen," of Christiania, Norway, calls attention to notices that have been given of Scandinavian observations in the past, of

phenomena parallel with the "after-glows" of 1883–'84. A series of these glows, observed in 1636, was ascribed at the time to the eruption of Hecla, which occurred in that year. From May to September, 1783, the heavens were illuminated by a constant red glow, and the sun had the appearance of a faint disk. This was attributed to a violent eruption of the Skaptar Jökul, Iceland, which occurred in the spring of the same year.

A CORRESPONDENT of "Nature," who has tried various schemes of automatic ventilation and found them all to fail at times, though usually working well, announces his conclusion that there is no rule in the matter without exception. This means that ventilation should receive personal attention, and be always under observation.

OBITUARY NOTES.

DR. THOMAS ANDREWS, an Irish chemist, died about the 1st of December, 1885, in the seventy-second year of his age. He was born in Belfast in 1813. In preparing himself for the medical profession he studied chemistry under several eminent masters. He took a part, as vice-president, in the organization of the Northern College, now Queen's College, Belfast, and was its first Professor of Chemistry. His name is identified with many most important investigations and discoveries. Among them are the composition of the blood of cholera-patients; the determination of heat evolved during chemical action; the true nature of ozone, in which he established the theory now universally held; and the continuity of the liquid and gaseous states of matter, a series of investigations which led directly up to Pictet's, Cailletet's, Wroblewski's, and others', successful liquefaction of all the gases.

XAVIER ULLESBERGER, a Swiss paleontologist, died recently at Ueberlingen, on the Lake of Constance, seventy-nine years old. He was the discoverer of the lake villages at Nussdorf, Maurach, Uhldingen, and Sipplingen; and he obtained a large collection of prehistoric objects, which is preserved at Stuttgart.

THE death is announced, at the age of eighty years, of Professor Giuseppe Ponzi, the Italian geologist.

PROFESSOR CHARLES E. HAMLIN, of the Agassiz Museum of Natural History, died at Cambridge on the 3d of January. He was about sixty years old.

ALFRED TRIBE, an English chemist, died November 26, 1885, aged forty-six years. He acquired his first knowledge of chemistry when, as a boy, waiting on the students at the Royal College, he repeated some of the experiments he saw performed, in the kitchen at home. He was assistant to Dr. J. H. Gladstone for twenty years, and head of his laboratory. He was Demonstrator of Chemistry at St. Thomas's Hospital, Lecturer on Metallurgy at the National Dental Hospital, and Lecturer on Chemistry and Director of Practical Chemistry in Dulwich College. He was an assiduous investigator, and published a large number of papers, some under his own name, and others in conjunction with Dr. Gladstone.

MR. EDWIN ORMOND BROWN, Assistant Chemist to the British War Department, died December 12th. He had been connected with the arsenal at Woolwich for about thirty years, and had been instrumental in the improvement of gun-cotton and other explosives.

DANIEL DAVID BETH, the chief of the Dutch African Expedition, died at Katumbella, on the 19th of May, 1885. He took part in an expedition to the interior of Sumatra, 1877 to 1879, where he became interested in the examination and prospective development of the coal-fields of the island. In 1882 he busied himself to secure a proper representation of the colonial products at the Amsterdam Exposition. In 1884 he started on his African expedition, which had especial reference to the Kunene River, and the mountain-range lying north and west of it.

DR. SAMUEL BIRCH, the chief of British Egyptologists, and founder and President of the Society of Biblical Archæology, died December 27th. He was born in 1813, and was appointed to the Department of Antiquities in the British Museum in 1836. He was at first specially interested in Chinese antiquities, but, without giving up his tastes in that direction, became pre-eminently an Egyptologist. Besides preparing numerous works and papers of his own, he contributed a translation of the "Book of the Dead," a dictionary of hieroglyphics, and a grammar to Bunsen's great work on Egypt. He was also connected, officially and personally, with the publication of "Records of the Past," twelve volumes of translations of the more important texts from the Egyptian and Assyrian monuments.

M. LOUIS RENÉ TULASNE, a French mycologist, whose fame would have been greater had he been less modest and enjoyed better health, died at Hyères on the 22d of December, 1885. He became a member of the French Academy in 1854, but was forced by his delicate constitution to retire from active life in 1864. During the twenty-five years to which his work was limited, he made many important investigations in the fungi and the lichens, the science of which, it is said, he reformed as well as augmented.

CHRISTIAN HUYGENS.